Exploring risk and sustainability performance in base of the pyramid supply chains

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SADAF AMAN

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Erster Gutachter: Prof. Dr. Stefan Seuring

Zweiter Gutachter: Prof. Dr. Wendy Tate

Dritte Gutachterin: Prof. Dr. Minelle Silva

Prüfer: Prof. Dr. Marcus Brandenburg
Dr. Mehrdokht Pournader

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IV. List of abbreviations

BoP	Base of the pyramid/Bottom of the pyramid
BoP-SCM	Base of the pyramid/Bottom of the pyramid-Supply chain management
BSC	Balance score card
EMS	Environmental management system
GDP	Gross domestic product
GHG	Greenhouse gas
GRI	Global Reporting Initiative
HRM	Human resource management
ICT	Information communication technologies
IGI	International Genealogical Index
IoT	Internet of things
ISO	International Organization for Standardization
KPI(s)	Key performance indicators
LCA	Life cycle assessment
LCC	Local community commitment
MNC(s)	Multinational companies
MNE	Multinational enterprise
NGO	Nongovernmental organization
OHS	Occupational health and safety
OHSAS	Occupational Health and Safety Assessment Series
ORQ	Overarching research question
PIs	Performance indicators
PM	Performance measurement
PMs	Performance measurement systems
R&D	Research and development
RM	Risk management
R-O-F	Resource-output-flexibility
RQ	Research question
SC	Supply chain
SCBSC	Supply chain balance score card
SCM	Supply chain management
SCOR	Supply chain operations reference

SCPM	Supply chain performance measurement
SCRes	Supply chain resilience
SCRM	Supply chain risk management
SSCM	Sustainable supply chain management
SSCPM	Sustainable supply chain performance measurement
TBL	Triple bottom line
UN	United nations
WHO	World health organisation
WOS	Web of Science

V. Abstract

In the contemporary business world, the real competition is not among individual businesses but rather between supply chains. Companies, which are part of efficient supply chains, are considered destined to outperform their competitors being part of inefficient supply chains. Moreover, performance has been a matter of concern for researchers for decades and is the primary aim of any firm's existence. The definition of performance includes the performance measurement (PM) concept and further supports the notion that PM improves visibility (Lauras et al. 2010) by taking prompt actions against threats, challenges, and barriers that are likely to disrupt the activities of the entire chain (Tummala and Schoenherr, 2011; Ivanov and Dolgui, 2020.). Literature defines these threats, barriers and problems as potential risks widely studied under supply chain risk management (SCRM) (Fan and Stevenson, 2018). Furthermore, the risk literature argues that the risk exacerbates with the environment (Tang, 2006), where the developing countries, discussed extensively under the base of the pyramid (BoP) literature, is considered relatively risker for the firms to operate efficiently, thereby offering an ideal context to explore SCRM. Therefore, the thesis investigates the intersection between SCPM-SCRM by using a combination of literature and empirical studies addressing overarching research questions of how can supply chain performance measurement help in managing risk? and what role do risk and performance management play in BoP supply chains and how it can be applied in the current situation?

To address the research question one, first a clear conceptualisation of performance in risk management. The literature on risk and performance management coin these two as inseparable terms, yet how these two influence each other within (sustainable) supply chain management (SSCM) is still undetermined. We explore various factors that influence decisions of supply chains considering risk and performance dimensions, where performance measurement (PM), its characteristics, and its role in supply chain risk management (SCRM) were explicitly discussed. First, a literature review was conducted to determine which PM tools, instruments, and indicators (PIs) have been used in the base-of-the-pyramid (BoP) literature and how they are associated with sustainability performance outcomes. Exploring SSCPM allows identifying key PIs (KPIs) considering all three dimensions of sustainability: social, environmental, and economic. Through a structured content analysis on 91 selected papers and the results interpreted using frequencies and contingency analysis, it was found that innovation is the core factor driving performance.

Second, risk management in the base of the pyramid (BoP) environment is needed to ensure that the firm's performance objectives are met. Accordingly, the intersection between SSCPM and SCRM is further tested by a literature review of 108 BoP SC articles between the years 2000 and 2019. Descriptive, frequency and correlation analysis identify various risk factors studied in the BoP literature so far, their management strategies and respective performance measures. The prominent findings show a broad strategical aspect of managing SC risks and proffered the tactical or operational level performance measures that can manage the related risks.

To address research question two, this dissertation includes the Covid-19 pandemic as a contextual orientation for empirical justification of the conceptualisation previously put forth. This is also done in two studies. First, a Delphi study method was employed to collect the expertise of global SC academics on the SC vulnerabilities and the measures for responding to disruptions, improving resilience, and restoring operations. Data from three polls are systematically analysed by content, frequency, and cluster analysis. The significant findings

identify that in regional comparison, China, Iran and Africa stand out, but Europe/North America, India/Pakistan, and Brazil show geographical particularities. The core findings also provide insights and challenges that the managers would have to meet in the different regions covered.

Second, specific attention to developing regions was given because they pose threats of extreme poverty and play an essential role in globalisation. A mixed-method approach was undertaken to address this novel pandemic situation. The data were collected in two phases, i.e., qualitative and quantitative, from three neighbouring emerging economies: Pakistan, India and Iran. Experts' perspectives on vulnerabilities, response measures, resilience and restoration of supply chain activities, and the role of social capital were collected. The findings from the first phase of the study inductively derive 36 resilience categories. Later, the contingency findings show that supply chain (SC) disruption is a major vulnerability for emerging economies, whereas solutions offered to combat it lay in reconfiguring resources, such as financial, technological, human, information and material. Additionally, supply network structure and social capital play an integral part in making SCs resilient against disruption.

Together, this dissertation explains and suggests several PIs analysed in the BoP literature and how these process level performance measures can circumvent the risks of operation in these markets. Similarly, while acknowledging the regional challenges Covid-19 posed on the global supply chains, this dissertation elaborates explicitly on the role of social networks using social network theory and social capital perspective to minimise disruption. Therefore, the dissertation offers clear theoretical contributions.

Practical implications include first, the highlighted PIs can be incorporated into the PM system to inform BoP policymakers to understand better how performance objectives can be achieved in BoP contexts. Further, the responses collected against the Covid-19 pandemic show differences among the regions thereby arguing that managers should take regional contingencies into account while managing global supply chains. Given that events, such as the Covid-19 pandemic, will become more frequent in the future due to climate change and geopolitical tensions, insights into how to manage SCs under extreme conditions and into regional differences are crucial.

Furthermore, the thesis also highlights gaps for future researchers to address, such as the PIs discussed in BoP literature are primarily conventional and need a sustainability perspective. The BoP literature also lacks an appropriate PM instrument and discusses predominantly specific indicators of these instruments, showing that research at the intersection of sustainable supply chain management (SSCM) and SCPM demands further development. Similarly, social network theory allowed devising several prepositions, however, these propositions are yet to be tested in industrial settings to see whether the results are limited to a specific industrial setting or are somewhat generalised. Lastly, practitioners and policymakers can incorporate the SCOR metrics/factors outlined throughout the dissertation into their PM systems and ensure continuous monitoring for firm's resilience against risks.

VI. Deutsche Zusammenfassung

In der heutigen Geschäftswelt findet der tatsächliche Wettbewerb vorrangig nicht zwischen einzelnen Unternehmen, sondern deren Lieferketten statt. Unternehmen, die Teil effizienter Lieferketten sind, sind ihren Konkurrenten, die Teil ineffizienter Lieferketten sind, überlegen. Darüber hinaus ist die Leistungsfähigkeit seit Jahrzehnten ein Anliegen der Forschung und stellt das Hauptziel jedes Unternehmens dar. Die Definition von Leistung schließt das Konzept der Performance-Messung (PM) ein und untermauert die Vorstellung, dass die PM die Sichtbarkeit verbessert (Lauras et al. 2010), indem umgehend Maßnahmen gegen Bedrohungen, Herausforderungen und Hindernisse ergriffen werden, die die Aktivitäten der gesamten Kette stören könnten (Tummala und Schoenherr, 2011; Ivanov und Dolgui, 2020.). In der Literatur werden diese Bedrohungen, Hindernisse und Probleme als potenzielle Risiken definiert, die im Rahmen des Risikomanagement in der Lieferkette (SCRM) umfassend untersucht werden (Fan und Stevenson, 2018). Darüber hinaus wird in der Risikoliteratur argumentiert, dass sich das Risiko mit dem Umfeld verschärft (Tang, 2006), wobei Entwicklungsländer, die in der Base of the Pyramid (BoP)-Literatur ausführlich behandelt werden, als risikoreich für Unternehmen gelten und somit einen idealen Kontext für die Erforschung des SCRM bieten. Daher wird in dieser Arbeit die Schnittstelle zwischen der Performance-Messung in der Lieferkette (SCPM) und SCRM anhand einer Kombination aus Literatur und empirischen Studien untersucht. Dabei werden die übergreifenden Forschungsfragen gestellt: Wie kann die Leistungsmessung in der Lieferkette beim Risikomanagement helfen? Welche Rolle spielen Risiko- und Leistungsmanagement in BoP-Lieferketten und wie kann es in der aktuellen Situation angewendet werden?

Zur Beantwortung der ersten Forschungsfrage ist zunächst eine klare Konzeptualisierung von Leistung im Risikomanagement erforderlich. In der Literatur zum Risiko- und Leistungsmanagement werden diese beiden Begriffe als untrennbar miteinander verbunden betrachtet, doch wie sie sich im Rahmen des nachhaltigen Lieferkettenmanagements (SSCM) gegenseitig beeinflussen, ist noch unklar. Wir untersuchen verschiedene Faktoren, die Entscheidungen von Lieferketten unter Berücksichtigung von Risiko- und Leistungsdimensionen beeinflussen, wobei die PM, ihre Merkmale und ihre Rolle im SCRM explizit erörtert werden. Zunächst wurde eine Literaturrecherche durchgeführt, um festzustellen, welche PM-Tools, -Instrumente und -Indikatoren (PIs) in der BoP-Literatur verwendet wurden und wie sie mit den Ergebnissen der Nachhaltigkeitsleistung in Verbindung stehen. Die Untersuchung der nachhaltigen Performance-Messung in der Lieferkette (SSCPM) ermöglicht die Identifizierung von Key-Performance-Indikatoren (KPIs), die alle drei Dimensionen der Nachhaltigkeit berücksichtigen: Soziales, Umwelt und Wirtschaft. Durch eine strukturierte Inhaltsanalyse von 91 ausgewählten Beiträgen und die Interpretation der Ergebnisse mit Hilfe von Häufigkeits- und Kontingenzanalysen wurde festgestellt, dass Innovation der wichtigste Faktor für die Leistung ist.

Zweitens ist das Risikomanagement im BoP Kontext erforderlich, um sicherzustellen, dass die Leistungsziele des Unternehmens erreicht werden. Dementsprechend wird die Schnittmenge zwischen SSCPM und SCRM durch eine Literaturanalyse von 108 BoP-Lieferketten-Artikeln aus den Jahren 2000 bis 2019 weiter untersucht. Deskriptive, Häufigkeits- und Korrelationsanalysen identifizieren verschiedene Risikofaktoren, die bisher in der BoP-Literatur untersucht wurden, sowie deren Managementstrategien und entsprechende Leistungskennzahlen. Die herausragenden Ergebnisse zeigen einen umfassenden strategischen Aspekt des Managements von Lieferketten-Risiken und bieten taktische oder operative Leistungsmaßnahmen, mit denen die entsprechenden Risiken gemanagt werden können.

Zur Beantwortung der zweiten Forschungsfrage wird in dieser Dissertation die Covid-19-Pandemie als kontextuelle Orientierung für die empirische Rechtfertigung der zuvor dargelegten Konzeptualisierung herangezogen. Dies geschieht ebenfalls in zwei Studien. Zunächst wurde eine Delphi-Studie durchgeführt, um das Fachwissen globaler Lieferketten-Wissenschaftler: innen zu den Schwachstellen von Lieferketten und den Maßnahmen zur Reaktion auf Störungen, zur Verbesserung der Widerstandsfähigkeit und zur Wiederherstellung des Betriebs zu sammeln. Die Daten aus drei Umfragen werden systematisch mittels Inhalts-, Häufigkeits- und Clusteranalyse ausgewertet. Die

wichtigsten Ergebnisse zeigen, dass im regionalen Vergleich China, Iran und Afrika hervorstechen, während Europa/Nordamerika, Indien/Pakistan und Brasilien geografische Besonderheiten aufweisen. Die Kernergebnisse liefern auch Einsichten und Herausforderungen, denen sich Manager: innen in den verschiedenen untersuchten Regionen stellen müssen.

Zweitens wurde den Entwicklungsregionen besondere Aufmerksamkeit gewidmet, da sie von extremer Armut bedroht sind und eine wesentliche Rolle im Rahmen der Globalisierung spielen. Um dieser neuartigen Pandemiesituation zu begegnen, wurde ein gemischter Methodenansatz gewählt. Die Daten wurden in zwei Phasen, d. h. qualitativ und quantitativ, in drei benachbarten Schwellenländern erhoben: Pakistan, Indien und Iran. Es wurden die Sichtweisen von Experten und Expertinnen zu Anfälligkeiten, Reaktionsmaßnahmen, Widerstandsfähigkeit und Wiederherstellung von Lieferkettenaktivitäten sowie die Rolle des Sozialkapitals erhoben. Aus den Ergebnissen der ersten Phase der Studie lassen sich induktiv 36 Resilienz-Kategorien ableiten. Zudem zeigen die Ergebnisse, dass die Unterbrechung der Versorgungskette eine große Schwachstelle für die Schwellenländer darstellt, während die Lösungen, die zu ihrer Bekämpfung angeboten werden, in der Neukonfiguration von Ressourcen wie Finanzen, Technologie, Personal, Informationen und Material liegen. Darüber hinaus spielen die Struktur des Versorgungsnetzes und das soziale Kapital bei der Widerstandsfähigkeit von Lieferketten gegen Störungen eine wesentliche Rolle.

In dieser Dissertation werden mehrere in der BoP-Literatur analysierte PIs erläutert und Vorschläge gemacht, wie diese Leistungsmaßnahmen auf Prozessebene die Risiken des Agierens auf diesen Märkten umgehen können. In ähnlicher Weise wird in dieser Dissertation die Rolle sozialer Netzwerke unter Verwendung der Theorie sozialer Netzwerke und der Perspektive des sozialen Kapitals explizit herausgearbeitet, um Störungen zu minimieren, während gleichzeitig die regionalen Herausforderungen, die Covid-19 für die globalen Lieferketten darstellt, anerkannt werden. Auf Basis dessen bietet die Dissertation klare theoretische Beiträge.

VII. List of contributions included in the dissertation

Peer-reviewed Journal Articles and Book Chapter (under review)

Aman, S., "The Inter-play between Performance and Risk in Supply Chain Management", In: Sarkis, J (ed) The Palgrave Handbook of Supply Chain Management. Palgrave Macmillan.

Aman, S., Seuring, S., Khalid, R.U., "Sustainability Performance Measurement in Risk and Uncertainty Management: An Analysis of Base of the Pyramid Supply Chain Literature", Business Strategy and Environment.

Peer-reviewed Journal Articles

Aman, S., Seuring, S., (2021), "Interestingly it's Innovation: Reviewing Sustainability Performance Management in the Base of the Pyramid (BoP)", Technovation. Volume 112, 102394. https://doi.org/10.1016/j.technovation.2021.102394.

Seuring, S., Brandenburg, M., Sauer, P., Schünemann, S. D, Warasthe, R, Aman, S., Qian, C., Petljak, K., Neutzling, M. D., Land, A., Khalid, R.U., (2022) "Comparing regions globally: Impacts of COVID-19 on supply chains – A Delphi study", International Journal of Operations and Production Management. https://doi.org/10.1108/IJOPM-10-2021-0675.

Aman, S., Seuring, S., (2021) "Analysing Developing Countries Approaches of Supply Chain Resilience to COVID-19", International Journal of Logistics Management. https://doi.org/10.1108/IJLM-07-2021-0362.

Peer-reviewed Conference Papers

Seuring, S., Brandenburg, M., Sauer, P., Warasthe, R, Schünemann, S. D, Aman, S., Qian, C., Petljak, K., Neutzling, M. D., Land, A., Oelze, N. (2021), "Comparing regions globally: Impacts of COVID-19 on supply chains – A Delphi study", *for* EurOMA, 28th annual conference Berlin, Germany

1. Introduction to the thesis

1. Motivation, background, and research questions

1.1. Research motivation

Supply chain management (SCM) enables the boundary-less management of its associated actors which has also increased the complexity of its management activities. The business world today is described as interlinked firms forming networks facilitating the efficient flows of products, capital and information across the globe. These chains or networks of interconnected firms are referred to as supply chains in the management-related literature (Mentzer et al. 2001). The term SCM denotes the management philosophies and practices employed to increase the efficiency and effectiveness of these complex networks or supply chains. Moreover, these management philosophies are further convoluted by incorporating management activities with a focus on environmental, social and financial performance. This brings sustainability into perspective and demands the management philosophies and practices to increase efficiency and effectivity considering these three sustainability performance dimensions. Therefore, SCM has evolved into sustainable supply chain management (SSCM).

Indeed, in the contemporary business world, the real competition is not among individual businesses but rather between supply chains. Companies, which are part of efficient supply chains, are considered destined to outperform their competitors being part of less efficient supply chains. Efficiency is determined by the ability of the firm to outperform its competitors in internal and external affairs (Maestrini et al. 2017). Performance has been a matter of concern for researchers for decades and is the primary aim of any firm's existence. The term performance has been operationalised into various "measures" to observe the growth and decline patterns in the supply chain. These performance measures are referred to as "metrics" or "indicators" and originate from the performance measurement (PM) literature (Maestrini et al. 2017; Aman and Seuring, 2021a). PM plays a crucial role in ensuring the effectiveness of the supply chains by making firms aware of their supply chain and operational activities (Maestrini et al. 2017; Simangunsong et al. 2012) because these PM systems improve the visibility (Lauras et al. 2010) of supply chains and thereby help in taking prompt actions against threats, challenges and barriers that are likely to disrupt the activities of entire chains (Tummala and Schoenherr, 2011; Ivanov and Dolgui, 2020.). Literature defines these threats, barriers and problems as potential risks widely studied under supply chain risk management (SCRM) (Fan and Stevenson, 2018).

SCRM is overall linked to the performance debate since the definition of risk management suggests that risks are managed so that their negative effect on performance can be minimised (Manuj and Mentzer, 2008). Besides, literature on SCRM suggests the use of several PM tools, instruments and indicators throughout the years (Koster et al. 2019; Seuring et al. 2019; Gold et al. 2013; Calton et al. 2013; Matos and Silvestre, 2013; Arnold and Valentin, 2013). More recently, Wicaksana et al. (2022) highlight the importance of measuring the SCRM performance and suggest that it improves the visibility of the entire supply chain because it identifies and mitigates risk propagation along the chain. Consequently, the role of performance in risk management is somewhat contested, hence still underdetermined (Kaplan and Norton 1996; Nanni et al. 1992; Schneiderman 1999; Neely 1999, Greatbanks and Boaden 1998; Lynch and Cross 1991; Neely et al. 2002, Lauras et al. 2010, Nooraie and Parast, 2015). Therefore, it is crucial to determine how the two influence each other.

Furthermore, Tang (2006) highlights that complication of identifying and dealing with the supply chain risks depends on the environment in which the firm and its actors operate. Therefore, a context defined as highly uncertain and riskier would contribute to the interpretation of the interplay between PM and risk management under the umbrella of SSCM.

1.2. Selecting a contextual field

With globalisation, the challenges related to sustainability have greatly increased. Together with the environment and economic sustainability, poverty has also become a growing concern of supply chain researchers as it triggers the social sustainability aspect. It also enables the firms to move beyond the limited scope and accept new ways to deal with the poor institutional conditions of the market which further elevates the concerns of poverty. The markets which are considered contributors to the global poverty level embody people who are living below the poverty line and usually encompass developing countries because of their low level of per capita income. The initial debate on developing countries' markets originated in 1998 as a specific domain from the work of Prahalad and Hammond. In their ground-breaking work in 2002, Prahalad and Hammond defined these markets specifically as the Base of the Pyramid (BoP) while emphasising that there is "fortune" in these markets.

The consumer-oriented perspective of Prahalad and Hammond (2002) suggests that the fortune in BoP is for multi-national corporations (MNCs) to tap the large consumer base of nearly 4 billion people. However, poverty alleviation is an essential consideration within the BoP context because it is associated with the challenges that poverty brings for the firms and solutions to increase the local living standard (Rosca et al. 2020). For example, the BoP embodies the marginalised people who create challenges for MNCs and other operating firms related to affordability. The demand of these people highly depends on their income level,

which requires firms to elevate their income level to a point where they can afford products offered by MNCs. Therefore, the consumer-oriented idea had been criticised for its limited scope (Karnani, 2007) and developed further into inclusive business practices considering the people in these markets as potential producers, co-developers, buyers, and suppliers (Reficco and Márquez, 2012). By considering the inclusive business perspective, MNCs and firms are required to create employment opportunities for these marginalised people and provide them with a platform to raise their living standards. However, research on BoP is still in its infancy and requires further in-depth investigations (Halme et al. 2012).

Further, inclusive business practices have proffered many challenges for firms operating or intending to operate in such an environment. The mere BoP environment has been characterised by institutional voids and informal market structures (Parmigiani and Rivera-Santos, 2015; Khanna and Palepu, 2005). The presence of institutional voids and informal market structures accentuates the BoP supply chain challenges and hinders the growth potential of the firms operating in this environment. For example, Reficco and Márquez (2012) contend that the lack of proper institutions is a significant obstacle in market processes as it breaks the link between market activities, creating the BoP environment risker for the firms to operate. Furthermore, the gap created between demand and supply due to voids leads to a decline in performance (Reficco and Márquez, 2012).

Moreover, the informal market structure makes it difficult for the focal firms to align their activities with upstream and downstream supply chain actors. However, the absence of a proper governance structure makes it difficult for the focal firms to keep track of their suppliers and buyers from informal markets (Silva et al. 2021; Parmigiani and Rivera-Santos, 2015). Therefore, poverty, institutional voids and informal structural patterns make the BoP markets vulnerable, thus prone to various risks. Consequently, it offers a perfect contextual lens to explore supply chain risks and supply chain performance measurement (SCPM).

In sum, the mere notion that the complication of identifying and dealing with the supply chain risks depends on the environment in which the firm and its actors operate (Tang, 2006). Considering the BoP environment is unique because the challenges faced by the supply chain actors in these regions are different from that of the developed world (Khalid et al. 2015). As discussed, its consumer orientation and inclusive business practices have proffered many challenges for researchers to address such as limited resources at hand (Arnold and Valentin, 2013; Anderson and Markides, 2007), lack of proper institutions, uneducated workforce, infrastructural issues, informal markets, etc. (Ansari, Munsir, and Gregg, 2012 ; Scott, 2017; Parmigiani and Rivera-Santos, 2015). Therefore, the institutional voids and informal market structure make these markets vulnerable, thus prone to various risks and severely affecting the

firm's performance. This offers a perfect contextual field for exploring the theoretical constructs of risk management and PM.

Besides, Tate et al. (2019) suggest that the BoP literature at the intersection of two themes, i.e., consumer orientation and inclusive business practices, is scarce while highlighting the need for a cohesive study analysing both sides of the coin. Accordingly, the BoP literature comprises these themes, thereby, considering them under risk and performance concepts offers a good step toward a cohesive study. Similarly, in the global supply chains where performance and risk have been discussed frequently and complement each other (Seuring and Muller, 2008), the intersection is still underexplored, both theoretically and in the BoP context. Therefore, this thesis strives to explore risk and performance with an aim to fill in these gaps that exist in literature and intends to offer implications that serve beyond the BoP context.

1.3. Research question investigated by the thesis

This dissertation explores the intersection between risk and performance within the BoP-SCM literature. For the said purpose, exploring performance management and risk management literature is a precursor. Accordingly, the overarching research questions (ORQs) taken up for this purpose are:

ORQ 1. How can supply chain performance measurement help in managing risk?

ORQ 2. What role do risk and performance management play in BoP supply chains and how can it be applied in the current situation?

The subsequent chapters will follow these ORQs by considering the sub-research questions originating from similar problem statements. Chapter 2 presents a book chapter that includes clear conceptualisations of PM and risk management and some definitions from the PM literature. Chapter 3 is a literature review on performance management in the BoP context. Chapter 4 explores the BoP-SCM literature at the nexus of PM and risk management further. Chapter 5 presents a visual representation of the nexus between PM and resilience by conducting a Delphi study taking a global perspective. Chapter 6 uses a mixed-method design to proffer the implications using a broad theoretical underpinning. Lastly, chapter 7 presents a general discussion on the contributions and limitations of the entire thesis, along with the conclusion.

2. Research strategy

In operations and SCM, a research strategy should derive from two classical philosophical approaches, i.e., ontology and epistemology, where the former determines the latter. The main

aim of describing these two philosophical choices here is merely to inform the design choices of the dissertation, hence, the debate on contrasting views of these philosophical choices is beyond the scope of this dissertation.

Ontology is a branch of philosophy which highlights the "assumptions of the nature of truth," i.e., the reality of the truth (Easterby-Smith et al. 2015, p. 9). However, epistemology builds on the philosophy of "how the knowledge is created" it is defined as "assumptions about best ways of enquiring the truth" (Easterby-Smith et al. 2015, p. 9). The literature informs various archetypes to illustrate different research orientations from the viewpoint of the researcher using these philosophical approaches.

Two commonly described archetypes of ontology include realism and relativism. Where the former talks about the existence of a single reality, and the latter builds on the notion that multiple realities exist (Easterby-Smith et al. 2015). Realism discusses that once scientific laws are discovered, they become absolute and independent of further observations. Contrastingly, the relativism approach emphasises that the truth is not just out there to be discovered, instead, it is created by people (Easterby-Smith et al. 2015). Therefore, these two archetypes define the nature of truth.

Furthermore, two commonly described archetypes for epistemology include positivism and constructivism. The positivist position builds on the assumption that there is a reality that exists independently of the observer. The researcher's job in this philosophical position is to discover the laws and theories that explain this reality and to measure the key factors precisely to verify or falsify predetermined hypotheses (Easterby-Smith et al. 2015). In contrast, the constructivist position allows the researcher to gather multiple different perspectives to inform many different realities (Easterby-Smith et al. 2015). While the former mainly includes experiments and survey design, the latter position nudges researchers to use qualitative and quantitative methodologies (Easterby-Smith et al. 2015).

From the two philosophical approaches to ontology explained, this dissertation has a clear tendency toward a relativist approach since the social science researchers are more inclined toward the argumentation of the existence of multiple realities which are relative to the people. However, from the epistemological, philosophical stance the dissertation finds a balance between the continuum of argumentations of positivist and constructionist positions, which further allows the observer to explore the multiple truths that exist in nature with the help of both "qualitative and quantitative methodological approaches" (Easterby-Smith et al. 2015, p 81). Therefore, these ontology and epistemology philosophical stances describe the author's view, which are further guided by the theorising strategies.

Qualitative and quantitative methods conform to the theorising strategy of the research. For the said purpose, Fisher and Aguinis (2017) propose a typology that includes: theory generation, theory testing, and theory elaboration. These three are further explained by applying input, process and tactics, and output in the table below:

Table 1.1 Contrasting theory generation, theory testing, and theory elaboration

	Theory Generation	**Theory Testing**	**Theory Elaboration**
Input	Unexplained phenomenon; little to no existing theory	Formal hypotheses derived from extant theory	Partially explained phenomenon; an existing conceptual model and/or ideas
Process and tactics	Induct constructs and relationships from data or develop and derive new concepts and relationships using logical, well-reasoned arguments	Collect and analyze data to assess whether they provide evidence supporting hypothesized relationships	Use existing concepts and models to collect and organize data to contrast, specify, and structure theoretical constructs and relations so as to refine existing theory
Output	New testable propositions; new constructs	Accept or reject hypotheses derived from extant theory	Refinement of existing theoretical ideas – refined contextual factors, constructs and/or relationships

Combining the contextual BoP debate with SCM demands using the theory elaboration approach. The initial arguments of selecting a contextual field suggest that BoP is a partially explained phenomenon within SCM, where in SCM, PM, risk management and resilience concepts and models exist that require specifying and structuring the theoretical constructs so as to refine existing theory. Furthermore, these concepts can be refined to proffer contextual factors specific to BoP or Covid-19. Taking SCM as a theory is also contested in the literature which further distinguishes between mid-range and grand theory (Craighead et al. 2016), however, debate on this is beyond the scope of this dissertation. Therefore, the "theory elaboration" is a suitable choice for the structure and research design of this dissertation.

3. Cumulative structure and research design of the thesis

The research strategy explained above shows that the author's orientation is more inclined towards theory elaboration by taking a relativist ontology and constructivist epistemology stance. It also serves as a guide for the structure of the thesis. First, the thesis will specify and structure the theoretical constructs such as SCPM and risk management to refine the existing theory. Second, these concepts will then be applied to the BoP context and Covid situation.

For the said purpose, first conceptualising the interplay between SCPM and SCRM offers a good starting point. This is explained in the second chapter of the thesis which also answers the

ORQ 1. Moreover, the individual chapters such as chapters 3, 4 and 6 apply distinct combinations of theoretical constructs and methods to investigate SCPM-SCRM in BoP supply chains. These chapters answer the ORQ1 and 2. Chapter 5 informs generic SCM and resilience literature. These combinations are described next.

The general SCM literature on PM and risk management presents several ideas, models and concepts, for example, Maestrini et al. (2017); Beske-Janssen et al. (2015); Simangunsong et al. (2012); Tummala and Schoenherr (2011). Exploring these concepts/frameworks by taking BoP literature covers chapters 3 and 4. Chapter 3 of the thesis is entitled *"Interestingly it's Innovation: Reviewing Sustainability Performance Management in the Base of the Pyramid (BoP)"* and published in Technovation. It explores the performance concept and uses a content analysis approach to refine the constructs to the applied context. It further employs frequencies and contingencies among constructs as found in the BoP-SCM literature. It discusses some emergent concerns and proffers implications of incorporating PMs in SCM for both practitioners and researchers.

Similarly, chapter 4 is entitled *"Sustainability Performance Measurement in Risk and Uncertainty Management: An Analysis of Base of the Pyramid Supply Chain Literature"*. It is also a systematic literature review and includes deductively derived supply chain risk and performance constructs and refines them further to the BoP context. The paper based on this chapter is currently under revision in Business Strategy and the Environment (BSE). The chapter seeks to explore the role of PM in RM as discussed in chapter 2. Besides, the chapter extends our understanding of the risk and the related strategies which are then linked to the PM.

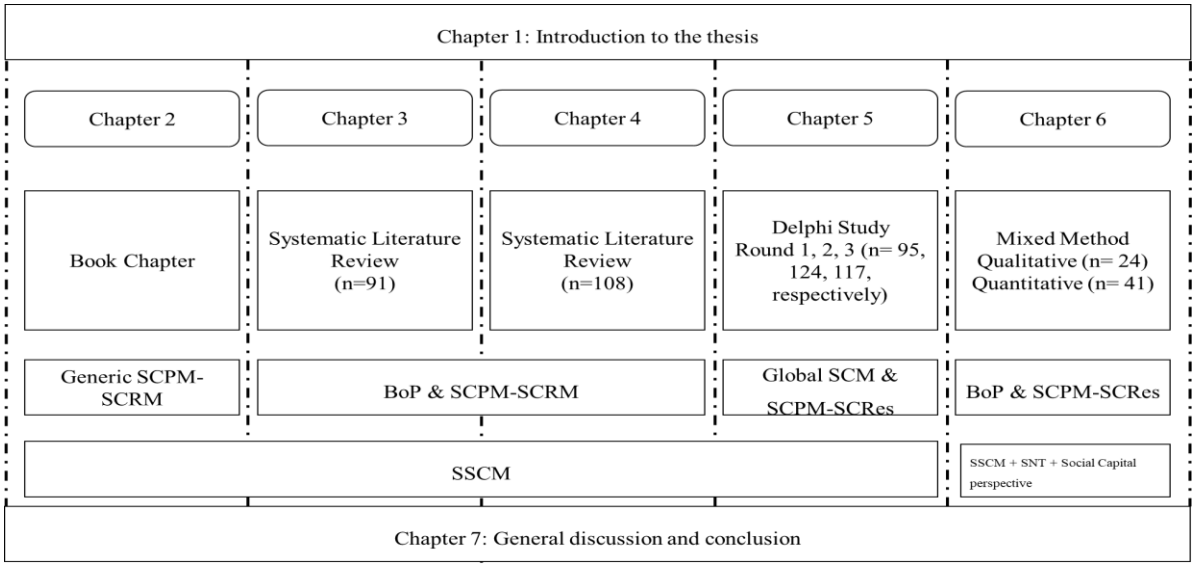

Figure 1.1 Research design and structure of the thesis

Chapter 5 is titled *"Comparing regions globally: Impacts of COVID-19 on supply chains – A Delphi study"*. It comprises a Delphi study taking a global perspective on resilience amid COVID-19. The resilience domain has evolved from risk management because it finds its strains in disruption risk (Pettit et al. 2019), and timely management of supply chains amid COVID-19 contributed to the exploration of the concept. The paper based on this chapter was presented at the 28th EurOMA conference and invited for publication. The paper is accepted for publication in the International Journal of Operations and Production Management (IJOPM). The paper explores the resilience concept and refines the theoretical constructs specifically considering the COVID-19 situation. The paper uses a cluster analysis to find the groups facing similar supply chain vulnerabilities. It also uses a SCOR model, a PM tool, to analyse heterogeneities within three major supply chain processes. Therefore, this chapter shows an empirical demonstration of the linkage between SCPM and supply chain resilience (SCRes).

Chapter 6 is entitled *"Analysing developing countries approaches of supply chain resilience to COVID-19"*. It is a theoretical extension of chapter 5 based explicitly on the developing countries' perspective on SCRes. The paper based on this chapter is published in the International Journal of Logistics Management (IJLM). The paper uses a mixed method design to elaborate on the various processes of the SCOR model. It builds on the resilience concept and incorporates the social network theory (SNT) and social capital perspective because it emerged as an important feature in the context of developing countries, which was also found in chapters 3 and 4. This chapter refines the constructs and/or relationships between the constructs presented in the SNT.

Table 1.2 Publication status of the chapters included in the dissertation

Chapter	**Publication Status**	**Journal/ Publisher**	**Short Reference**	**No. of authors**
2	Under Review	Palgrave Macmillan	-	1
3	Published	Technovation	(Aman and Seuring, 2021a)	2
4	Under Revision	Business strategy and the environment	-	3
5	Accepted for publication	International Journal of Operations and Production Management	(Seuring et al. 2022)	11
6	Published	International Journal of Logistics Management	(Aman and Seuring, 2021b)	2

As shown in Table 1.2, three of the five chapters of the thesis are either published or accepted for publication in scientific journals in the field of (S)SCM. Additionally, chapter 2 is currently under review and chapter 4 is currently under revision. The table also displays that one chapter is single-authored, and two chapters are co-authored by the author and Prof. Dr. Stefan Seuring. The other two chapters include three or more renowned scholars from around the world. The fair share of each co-author is also declared in point III. In conclusion, the dissertation complies with the current publication requirements for cumulative dissertations of the University of Kassel in general and the Faculty of Business and Economics in particular. Following the structure of the dissertation displayed in Figure 1.1 and Table 1.2, the first book chapter entitled "The Inter-Play between Risk and Performance in (Sustainable) Supply Chain Management" is now presented.

2. The Inter-Play between Risk and Performance in (Sustainable) Supply Chain Management

This chapter represents a prospective book article by the author of this dissertation. It is in preparation for the Project *The Palgrave Handbook of Supply Chain Management*.

Abstract

Risk and performance are inseparable terms, yet how these two influence each other within (sustainable) supply chain management (SSCM) is still undetermined. In this chapter, we explore various factors that influence decisions of supply chains considering risk and performance dimensions. We specifically discuss performance measurement (PM), its characteristics, and its role in supply chain risk management (SCRM). The chapter includes an introduction and background of SCRM and how it links to PM. Further, it identifies dimensions of PM and options to integrate it in SCRM. The link will encourage managers to consider PM characteristics in risk management to improve overall sustainability. Emergent concerns and future directions are also presented.

Keywords Performance, risk management, sustainable supply chain management, performance measurement

1. Introduction

Risk and performance are old concepts coining its history from the strategic management literature (Miller and Bromiley, 1990) where financial risk was the primary focus and measured through research and development (R&D) intensity, standard deviation of return on asset (ROA), return on equity (ROE), variance from stock analyst earnings forecasts etc (Miller and Bromiley, 1990). However, the negative deviation and variance in the performance objectives indicate the presence or absence of certain risks. Early literature tries to identify the causality between the two by implying performance as a driver of risk (Bowman, 1982) and discusses the influence of performance on risk and vice versa (Miller and Bromiley, 1990). It suggests an inter-play between performance and risk exists from the beginning of the risk management debate which somewhat builds on the narrative "what is not measured is not managed" (Manuj and Mentzer, 2008, p 216). The performance is widely studied as performance measurement (PM) while risk is studied under risk management (RM). Building on this, the following arguments explain how this interplay has been evolved with the evolution of the respective domains.

In the literature of RM, risk measurement or assessment, so far, has been treated as subsequent process after risk identification to check the magnitude and probability of the identified risk (Tummala and Schoenherr, 2011). Similarly, RM literature cultivates on two broad types of risk management strategies, i.e., preventive and reactive (Thun et al. 2011). Where Gouda and Saranga, 2018 contend that "both preventive and reactive risk mitigation strategies are devised before a risk event occurs"(p. 3), where former reduces the effects of risk before its occurrence while latter mitigate the effects after a risk has been occurred. For preventive strategies, the perceptions regarding risk are formed on basis of various parameters for example past experiences, risk preferences and infrastructural robustness and concludes that the firms need to "track" the actual risk highlighting the need for proper control and monitoring (Gouda and Saranga, 2018). Therefore, to ensure that the risk management strategies cascade down and lead to concrete actions, a conscious effort in linking PM with risk management strategies is a prerequisite.

Furthermore, a recent shift has been seen in the researcher's endeavours to establish a link between performance and risk management by characterizing the former as an antecedent to latter (Munir et al. 2020). It highlights that less attention has been given to the point of how a company can identify these potential risks? Or what drives risk management? i.e., the antecedents of risk management (Fan et al, 2017; Manuj and Mentzer, 2008). Following the logic presented above and putting PM as a subsequent risk control and monitoring phase will allow managers to detect risk in case of any diversion noticed from the set performance measures. Therefore, the companies with PM improve their visibility by detecting early diversions from the set targets thereby PM can also be viewed as a determinant of risk management. Conclusively, the chapter aims to define the role of PM as both the antecedent and the consequence of risk management in the risk management process.

Furthermore, the PM philosophies are convoluted by incorporation of management activities beyond the organizational boundaries. The business world today is described as interlinked firms forming networks facilitating the efficient flows of products, capital and information across the globe. These chains or networks of interconnected firms are referred to as supply chains (SC) in the management related literature (Mentzer et al. 2001). The changing paradigms of today's business necessities researchers and practitioners to focus on supply chains performance measurement (SCPM), however, the mere narrative of boundary less management of its associated actors and activities increases complexity and exposes firms to supply chain risks. Therefore, measuring performance for supply chain risk management (SCRM) has become the crucial criteria for firms to become successful.

Moreover, recent focus of researchers on environmental and social performance along with the financial performance brings sustainability into the perspective which is also referred to as triple bottom line. Therefore, SCM has now evolved to sustainable supply chain management (SSCM). The concerned literature also suggests that "the sustainability performance management is not often due to direct demand enforced by the legal act but because the companies aim to reduce the related risks" (Seuring and Müller, 2008, p. 1703). For example, a focal firm implementing an environment certificate implies that the firm wants to avoid the associated risk of reputational loss this links PM to risk management. Therefore, understanding that risk is an obscure reality in SSCM and an inseparable concept from performance, where exploring and linking the two is a precursor in minimizing SC problems, hence, the chapter addresses the question:

How the concepts SCRM and SCPM can be linked under SSCM?

The subsequent sections of the chapter discuss historical view and practices in SCRM and prudently links it to the SCPM by taking studies considering it as an antecedent as well as consequence of RM. Next, SCPM characteristics are presented considering its evolution under (sustainable) supply chain management. Further, current concerns are highlighted, furthermore, emergent concerns, outstanding research, and future directions are discussed. Lastly, managerial implications are presented along with the conclusion.

2. Background

There are numerous definitions of risk proposed in the literature of supply chain risk management and almost all of them inevitably links performance to risk management. For example, Manuj and Mentzer (2008) define risk as "the distribution of outcomes related to adverse events" (p. 197). Similarly, Tummala and Schoenherr (2011) conceptualize supply chain risk in more detail as "an event that adversely affects supply chain operations and hence its desired performance measures, such as chain-wide service levels and responsiveness, as well as cost" (p. 474). The former definition argues the effect of risk on strategic performance whereas the latter argues its effect on strategic performance through short term performance measures. These short-term performance measures are devised based on the strategic choice of managers for reducing and mitigating risks. For example, Rogerson et al. 2022 analyse disruption risk and proposed measures for two disruption management strategies i.e., flexibility and redundancy. Moreover, Choi et al. (2018) stress on trust and trust worthiness as two critical components of collaboration. In RM, collaboration is a risk reducing strategy (Simangunsong et al. 2012) where trust and trust worthiness are intangible relational performance measures (Aman and Seuring, 2021a, Maestrini et al. 2017). These short-term performance measures are

a part of performance measurement initiative, thus known as PM metrics, indicators or measures.

For many years, it has been recognized that PM can affect the successful implementation of company strategy (Laihonen and Pekkola, 2016). It ensures that the company's strategies are competently and wholly implemented to sustain the organization's growth (Rompho, 2011). A PM must be designed and implemented in accordance with a company's business strategy and must link the strategy to the objectives of functions, groups of people, and individuals (Kaplan and Norton 1996; Nanni et al. 1992; Schneiderman 1999; Neely 1999), as well as to operations (Greatbanks and Boaden 1998; Lynch and Cross 1991; Neely et al. 2002). PM further includes tools, systems, instruments and indicators which can further be regarded by the managers in implementing the strategies for risk management. For example, Lean operations is a risk reducing strategy incorporating Lean Six Sigma tool devoted to control and measure quality that can be seen under two perspectives, either linked to total quality management (i.e., a performance measurement system) or as a continuous improvement approach (Aboelmaged 2010). Similarly, lead time management through just-in-time modelling, which usually focuses on the link between changes in different production factors and the corresponding production performance measures (Banker et al. 1993). This perspective discusses the influence of risk on the performance and specifically entails that PM is important in the implementation of SCRM strategies.

In contrast, Lauras et al. 2010 contend PM as a perspective that enhances the visibility of the SCs. Where visibility has been desirable as it increases efficiency in the SC and decreases risk (Nooraie and Parast, 2015). Similarly, an empirical study by Brandon-Jones et al. (2014) on 264 UK manufacturing plants found that visibility is positively related to disruption risk. This further has been postulated by Yang et al. (2021) as they found SC visibility is an antecedent to SCRM capabilities. Moreover, Munir et al. 2020 suggest integration, a performance measure, improves the visibility of SC and a potential antecedent to SCRM. This perspective implies influence of performance on risk and specifically discusses PM as a perspective that improves visibility of the SCs. Therefore, the role of PM in SCRM is twofold. On the one hand literature considers it a consequence (Tummala and Schoenherr, 2011) and on the other hand it is viewed as an antecedent to SCRM (Munir et al. 2020).

The former conceptualization has been long considered in the SCRM literature (Gouda and Saranga, 2018; Simangunsong et al. 2012; Ritchie and Brindley, 2007), however, less attention has been given to performance as an antecedent of SCRM (Fan and Stevenson, 2018; Fan et al. 2017; Manuj and Mentzer, 2008). This later conceptualization can further be viewed in the light of chaos theory which defines systems as complex as opposed to deterministic, in which if the

equations describing its behaviours as nonlinear then the slightest change in the initial conditions can lead to cataclysmic and unpredictable results (Levy, 1994). The theory supports the argument of short-term PM to observe change in the initial conditions to timely understand the risks prior to their occurrence (Levy, 1994). Therefore, PM on the one hand, facilitates short term visibility that is necessary for risk management and strategic performance outcomes, on the other hand, it offers operational or tactical measures for risk management strategies to successfully implement the RM strategies devised by the managers, thus both sides of the coin are presented in a coherent manner to facilitate the conceptual argumentation of interplay between performance and risk. Therefore, the subsequent sections, 2.1 and 2.2, explain SCRM and SCPM respectively.

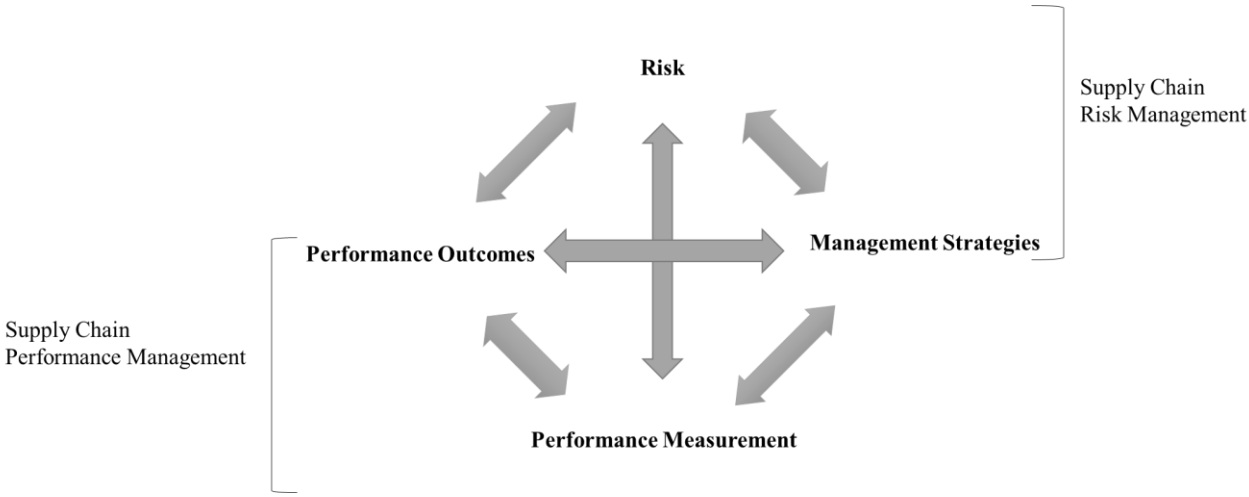

Figure 2.1 Conceptualizing SCPM in risk management

2.1. Supply Chain Risk Management

Today's market environment is considered fragile and requires swift actions for risk management to control its effects on performance. Risk management involves identifying and assessing risk and devising the strategies accordingly, but once the strategies are devised, concrete actions are required to ensure any diversion from the intended outcomes. These considerations demand concrete monitoring of the risk to achieve strategical performance outcomes. One way of doing this is by linking PM with the risk management.

Sustainability Performance Measurement in Supply Chain Risk Management

SC risk management is broadly divided into three broad steps, i.e., identification and assessment, evaluation, planning and mitigation, control and monitoring. The identification, assessment and evaluation of the risks is step one and can tell the probability and magnitude of

their occurrence alone. Once identified and evaluated, related risk management strategies (step two) are devised, which then lead to control and monitoring (step three). To understand the SCRM, all these things need to be explored.

Step One

The identification, assessment and evaluation of risk is operationalized into number of potential risks that a firm encounters in its span, including assessing the probability and impact of the risks. Most common and widely discussed risk factors include demand risk, supply risk, distribution risk, transportation risk, delay risk, supplier risk, manufacturing risk, capacity risk, sovereign risk, system risk and most recently, disruption risk. The disruption risk is a relative term which has often been discussed with the resilience concept.

Step Two

Risk planning and mitigation require a set of strategies that need to be deployed to mitigate related risks. Within the broader prospect of risk management, it is managed at strategical and tactical levels. The strategical level risk is often directed towards the probability of occurrence of a certain event, for which preventive risk strategies could lead to positive outcomes. The practices include the product design, shorter planning period, good decision support system, collaboration decision policy & procedures, use of information communication and technological (ICT) system, pricing strategy, redesign of chain configuration and/ or infrastructure. These practices are devised to reap long term strategic benefits as well as protection against risks. The tactical level is linked to the operational level risk and often needs reactive mitigation strategies to reduce their effects on performance. Risk mitigation literature identified reactive mitigation strategies such as postponement, volume/delivery flexibility, process flexibility, customer flexibility, multiple suppliers, strategic stocks, lead time management, financial risk management, and quantitative techniques.

Step Three

Once the strategy is decided by the top management to prevent or mitigate a risk then related action plan needs to be devised, this step combines two phases of SCRM i.e., a) implement and execute and b) review, and adapt (Ha and Tang, 2017). Institutionalizing PM approaches will help in addressing the most critical risks, while measuring the amount and need of resources such as information, material, finance or products. First, it facilitates the implementation and execution of the risk management strategies by tracking and evaluating the performance measures linked to them (e.g., Chenhall and Langfield-Smith, 2007; Laihonen and Pekkola 2016; Blos et al. 2009). Second, the risk response actions can be reviewed and adapted

according to the priority and the available resources which become visible with performance metrics or indicators measuring them (Laura et al. 2010). For example, a strategy such as "postponement" is devised for managing "capacity risk" and related performance measure such as "cost" linked to postponement can be analyzed. Measuring cost and information throughout the chain then depicts the decoupling point so to avoid the capacity risk. Accordingly, these performance measures or indicators can be proffered by different functional units of an organization (Chenhall and Langfield-Smith, 2007; Laihonen and Pekkola 2016) as well as upstream and downstream suppliers and buyers can be incorporated to devise the indicators for the entire chain. Moreover, the PM tools can also be incorporated in triggering defects in a firm's operations through continuous auditing and reporting of changes once the risk management strategy has been implemented (Arzu and Erman, 2010) Therefore, incorporating these sustainability PM efforts as control and monitoring initially check that the risk management strategies have been cascaded down the organization and reap strategical performance outcomes as intended and further improves visibility to detect early threats of risks and adapt accordingly to ensure that the maximum risk can be avoided. Section 2.2 explains most commonly used performance measurement systems, tools, instruments, and indicators in performance management literature that can be incorporated into the SCRM. It ranges from deciding the measurement tools, instruments to specific indicators.

2.2. Supply Chain Performance Measurement

Supply chain performance measurement can be defined as a set of metrics used to assess the efficiency and effectiveness of supply chain processes and relationships, spanning multiple organisational levels and multiple firms. The focus here is on the "metrics" that are used to access efficiency and effectiveness. These performance measurement metrics can be derived from various measurement systems, tools, and instruments. The literature further distinguishes between these tools, systems, and instruments based on their focus. The performance measurement tools can be categorised as instruments, system, or concepts (Beske-Janssen et al. 2015). Whereas the PM instruments have a narrow focus and are categorised as indicators, labelling, reporting etc. (Beske-Janssen et al. 2015; Schaltegger et al. 2014, Aman and Seuring, 2021a). Other examples of instruments include benchmarking, auditing, and lead-time reduction etc. These performance measurement instruments are further analysed through specific PIs at organizational, operational and supply chain levels.

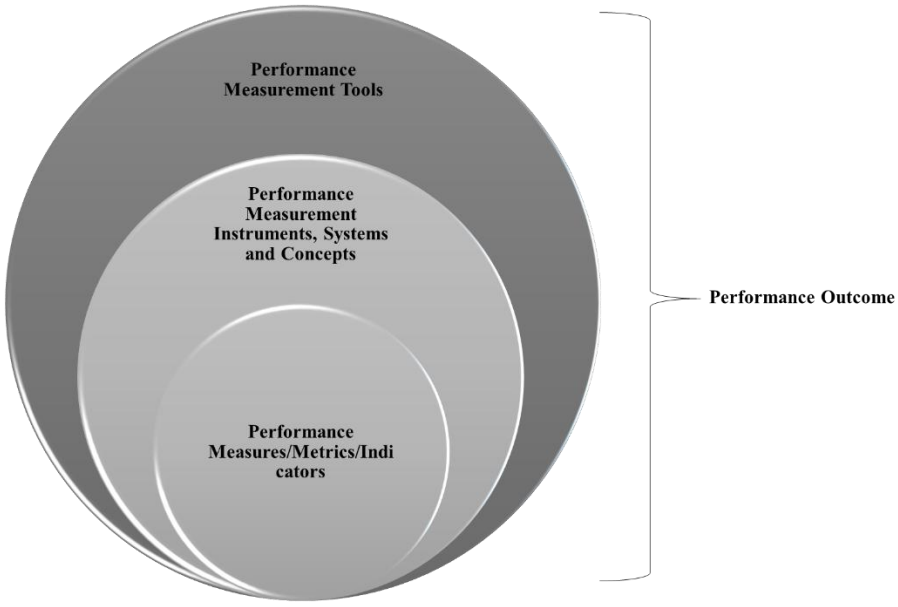

Figure 2.2 Performance measurement attributes

Performance measurement Tools (correspondence):

Quality standards (ISO 9001) "ISO 9000 is about quality systems and consistency. It aims to give customers confidence in their suppliers by assuring them that the suppliers have in place management processes that deliver consistency. It encourages but does not of itself directly assure product quality" (Terziovski et al. 1997, p. 1).

Environmental standards and certificates An EMS helps companies reach the same standards in their business operations using similar policies and standards for environmental protection (Huber and Bassen, 2018).

Social certification Social certificates are a coordinated and systematic approach to managing health and safety risks by maintaining social standards such as OHS; SA8000; OHSAS 18001 (Gold et al. 2010)

Sustainability standards These refer to the standards or rules, procedures, and methods used to systematically assess, measure, audit, and/or communicate the social and environmental behaviour and/or performance of firms (Gilbert et al. 2011)

Performance measurement Systems:

Quality Management System A management system which uses the ISO quality certificates for managing the quality of the products. (Beske-Janssen et al. 2015)

Environmental Management System (EMS) "ISO defines an EMS as 'that part of the overall management system which includes organisational structure, planning, activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing, and maintaining [the organisation's] environment policy" (ISO, 1996).

Social Management System A management system which includes the social ISO certificates for managing the social impact and also includes the occupational health and safety system (OHS). (Beske-Janssen et al. 2015)

Integrated Management System A management system which uses integrated managing tools such as Global reporting initiative (GRI) and UN global impact (Beske-Janssen et al. 2015)

Performance measurement concepts:

Corporate citizenship "At a minimum, corporate citizenship means the conduct of business in ways that reflect proactive, responsible behaviour in business and dealings with all constituents and with respect to communities, society, and the natural environment more generally" (adapted from Logan et al. 1997, p. 7).

Stakeholder dialogue "In the dialogue with stakeholders (both primary and secondary) opinions are exchanged, (future) interests and expectations are discussed, and standards are developed with respect to business practice" (Kaptein and van Tulder, 2003, p. 208).

Sustainability Balanced Score card The well-known four dimensions of the BSC developed by Kaplan and Norton, (1992) (i.e., finance, customer, internal business process, learning and growth) are shaped according to the SCM scope, by considering: SCM goals, end-customer benefit, financial benefit, SCM improvement. The idea behind the SCBSC is to design a SC strategy coherent with the business strategy, including critical success factors within the four performance dimensions above (Maestrini et al. 2017).

Supply chain operations reference model Set of metrics grouped according to the five distinctive management processes, namely plan, source, make, deliver and return. These metrics are also classified according to their strategic, tactical or operational nature (adapted Maestrini et al. 2017)

R-O-F model Resources: various dimensions of cost are monitored (e.g. distribution cost, manufacturing cost) with the purpose of fostering efficiency, Output: various dimensions of customer service are reported, Flexibility: it measures the ability to respond to a changing

environment. This framework is thought to assess the SCM capabilities of a specific firm and keeps a mainly internal perspective. (Maestrini et al. 2017).

Performance measurement Instruments:

Life cycle assessment Life cycle assessment is a "cradle-to-grave" approach for assessing industrial systems. LCA evaluates all stages of a product's life from the perspective that they are interdependent, meaning that one operation leads to the next (Curran 2006).

Eco-audit "Eco-auditing is also applied to methods of describing the state of the environment and environmental impact analysis [...]. [...] the management approach, evaluating to what extent the organisation complies with internal and/or external environment requirements" (Aall, 1999, p. 152).

Environmental benchmarking "Through benchmarking, companies are given a mark for their actions and achievements, which enables stakeholders to judge how responsible a specific company is" (Graafland et al. 2004, p. 139).

Environmental reporting "[This is the] process of communicating the environmental effects of organisations' economic actions to particular interest groups within society and society at large" (Nitkin and Brooks, 1998, p. 1499).

Financial report This is an annual report published by companies that tells society at large about the companies' financial situation, including profit or loss for particular periods (Nitkin and Brooks, 1998).

Social audit A "social audit attempts to provide a mechanism for decision-makers to evaluate economic and social planning, facilitate popular involvement in economic decisions and identify the social need as a primary criterion for resource allocation" (Owen et al. 2000, p. 83).

Social benchmarking "Through benchmarking, companies are given a mark for their actions and achievements, which enables stakeholders to judge how responsible a specific company is" (Graafland et al. 2004, p. 139).

Social reporting This is the process of communicating the social effects of organisations' economic actions to particular interest groups within society and society at large by publishing reports (Nitkin and Brooks, 1998)

Sustainability audit and monitoring Sustainability auditing refers to characteristics such as suppliers' compliance with the measurable standards that are employed to assess

environmental management, the use of a trained audit team, and the organisation's release of progress reports.

Sustainability monitoring includes the evaluation of suppliers by auditors vis-à-vis ability to meet measurable standards and improving the flaws by training them. (Seuring et al. 2019)

Sustainability benchmarking "Through benchmarking, companies are given a mark for their actions and achievements, which enables stakeholders to judge how responsible a specific company is" (Graafland et al. 2004, p. 139).

Sustainability reporting "One trend that is also apparent in many parts of the world is the tendency of companies to produce separate social and environmental reports. In this context, such reports are generally termed as CSR reports or sustainability reports, depending upon the development of the corporation concerned" (Aras and Crowther, 2009, p. 283).

Performance metrics:

Performance metrics levels

The performance metrics can be devised for two organizational levels, i.e., strategical and process.

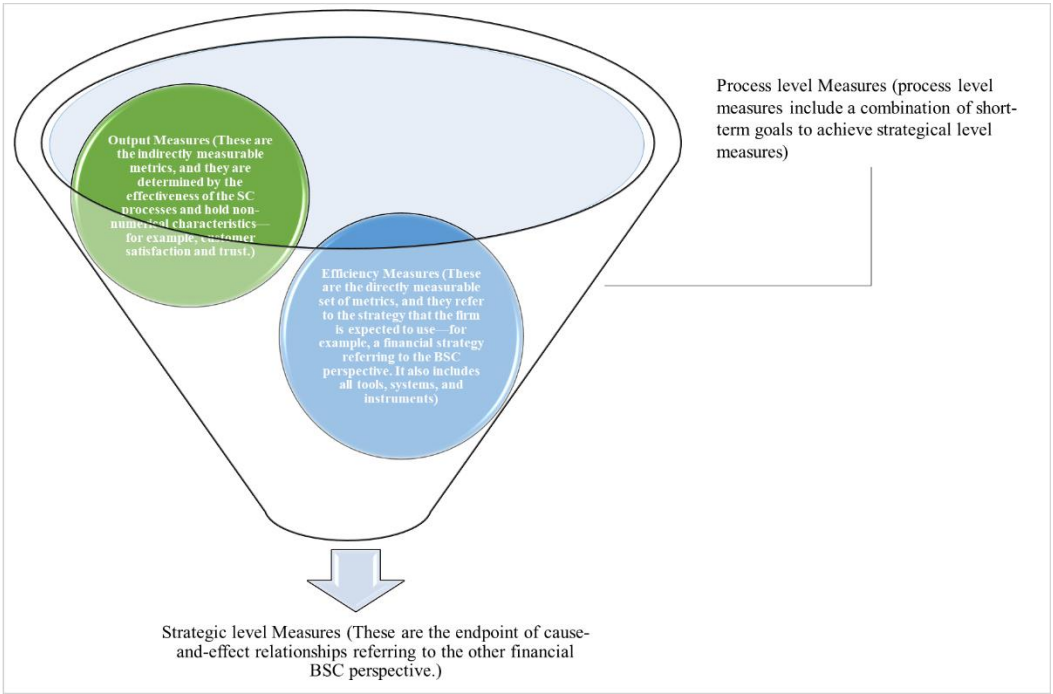

Figure 2.3 Strategic and process level performance measures

Strategical level

A firm's strategical level measures include its final objectives, long term goals or outcomes. These strategical level performance measures often considered separately from the PM and are the strategic consequence of management strategies (Aman and Seuring, 2021a). Therefore, this level represents the vision of an organization and thus includes long-term goals, for example, sustainability.

Economics/business performance Financial gains yielded from a business activity—that is, profitability, revenue, and economic growth. The endpoint of the cause-and-effect relationship.

Sustainable competitive advantage It is achieving and maintaining a competitive advantage as a result of business activity.

Operational performance Cost reduction, speed, time, flexibility, dependability, output quality achieved, new quality product developed.

Social performance Social benefits achieved as a result of a business activity—poverty alleviation, empowerment, inclusiveness, and so on.

Environmental performance Environmental benefit achieved as a result of business activity—that is, energy consumed, waste produced, improved air quality, and so on.

Sustainability development Development of all three dimensions of sustainability: social, economic, and environment, i.e., not focusing on performance outcome of a single dimension.

Process level

A firm's process level measures include a combination of short-term goals which are deployed to achieve strategical level goals. Process level measures further hold tangible or intangible characteristics (Hervani et al. 2005). The tangible measures include greenhouse gas (GHG) emissions and waste production, which are used to observe growth or decline patterns in SC processes. These tangible measures are measured directly (i.e., numerically) and the literature suggests that they should be used to assess the efficiency of SC processes (Beske-Janssen et al. 2015). The intangible measures are also present in the performance measurement. These performance measures are determined by the effectiveness of SC processes, such as customer satisfaction, trust, and commitment. For example, trust is a non-numerical measure that can determine the reliability of the relationship between two SC actors. Because this relationship cannot be directly assessed, the actors assume trust in each other if they adhere to the standards that they set mutually, such as those required for ISO certification. Therefore, these measures are labelled as output measures, and they hold intangible characteristics. In sum,

the efficiency measures have tangible characteristics while output measures hold intangible characteristics.

Efficiency measures:

Financial The financial perspective indicates whether the transformation of a strategy leads to improved economic success. Financial performance here is defined as a process rather than an end point of the cause-and-effect relationship. (Figge et al. 2002)

Customer "The customer perspective defines the customer/market segments in which the business competes. By means of appropriate strategic objectives, measures, targets and initiatives the customer value proposition is represented in the customer perspective through which the firm/business unit wants to achieve a competitive advantage in the envisaged market segments" (Figge et al. 2002, p. 271).

Cycle time "Cycle time refers to the time it takes from initiation to completion of the purchasing process" (Hult et al. 2002, p. 580).

Cost Cost is usually a monetary estimation of effort, material, resources, time and utilities consumed, risks incurred, and opportunity forgone in the production and delivery of a good or service—that is, cost-efficiency. (Adegbile and Sarpong, 2018)

Quality Quality includes a tangible dimension, i.e., it deals with procedures and specific systems which are established to provide the goods or service.

Asset Asset attribute refers to the effectiveness of asset utilisation measured in terms of cash-to-cash cycle time, return on fixed assets, and return on working capital. (Heuër, 2017)

Resources Resource measures include tangible resources, such as capital requirement, inventory levels, and equipment utilisation.

Flexibility Flexibility refers to how easy it is for an SC to change based on its range of options. (Ahrens et al. 2019)

Gender diversity This refers to the consideration of gender diversity in the life cycle of a product. "It is the proportion of males to females in an organisation that can affect the way in which they interact and behave with one another at the workplace, and thereby impact the social and cultural environment" (IGI Global, 2020).

Human rights This refers to the consideration of human rights in the life cycle of a product. Human rights include the right to life and liberty, freedom from slavery and torture, freedom of

opinion and expression, the right to work and education, and many more. Everyone is entitled to these rights without discrimination (United Nations, 2020).

Fair trade This is the consideration of fair trade in the life cycle of a product. Fairtrade means that the producers receive prices that cover their average costs of sustainable production, the premium which can be invested in projects that enhance social, economic and environmental development (Fairtrade International, 2019).

Fair labour This is the consideration of fair labour in the life cycle of a product. "This includes paying less than the minimum wage, employing young children, and working employees for long hours without premium overtime pay" (Goldstein et al. 1999, p. 1003).

Child labour This is the consideration of child labour in the life cycle of a product. "A child (5–14 years) is defined as economically active if he or she works for wages (cash or in-kind); works on the family farm in the production and processing of primary products; works in family enterprises that are making primary products for the market, barter or own consumption; or is unemployed and looking for these types of work" (Edmonds and Pavcnik, 2005, p. 201).

Waste production This is the consideration of waste production in the life cycle of a product: the production of unwanted materials as a by-product of economic processes (Sustainable Development Indicator Group, 1996).

Greenhouse gas (GHG) emission This is the consideration of GHG emission in the life cycle of a product for example, CO2, SOx, and NOx. The emissions of harmful gases into the air is called air pollution because they alter the chemical composition of the natural atmosphere. (adapted from Daly and Zannetti, 2007)

Noise pollution This refers to the consideration of noise pollution in the life cycle of a product. Noise pollution is generally defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms (Environmental Pollution Centres, 2019).

Recycling This is the consideration of recycling in the life cycle of a product. Recycling means the processing of waste (i.e., unwanted or useless materials) and its (re)introduction back into the material cycle so that contamination of the environment is minimised. (Tanskanen, 2013)

Pollution This is the consideration of pollution in the life cycle of a product. Pollution is the introduction of harmful materials into the environment which further damage the quality of air, water, and/or land. (adapted from Daly and Zannetti, 2007)

Innovation Innovation is the setting up of a new production function. This covers the cases of a new commodity and new ventures—that is, an organisation or a merger—or the opening of new markets, new relationships, new products, or new marketing infrastructure (Hall et al, 2014)

Output measures:

Resources Resource measures also include intangible resources, such as personnel requirements, and relations, information etc.

Quality Quality also includes an intangible dimension which deals with the interactions among workers and their attitudes and behaviours with customers.

Customer satisfaction/expectation Various dimensions of customer service are reported. Output measures include customer satisfaction measured through return on the quantity and quality of the products being produced and customer expectation through being more considerate and responsive to customer demand. (Viswanathan et al. 2012)

Local community commitment (LCC) This is the consideration of the local community in the life cycle of a product. LCC means taking the long-term views and embeddedness of firms in local communities into account to deal with the local contestations for survival that filter into the everyday lives of the poor (Ansari et al. 2012)—for example, social inclusion.

Social capital Social capital refers to three broad forms of capital further measure through structural capital, relational capital and cognitive capital. (Nahapiet and Ghoshal, 1998)

Trust The degree of reliability enjoyed between the SC partners which also facilitates SC processes (Al-Saa'da et al. 2013)

Commitment Commitment may be defined as the relative strength of an individual's identification with and involvement in a particular organisation (Steers, 1977)

Integration Integrating suppliers, buyer and intra-firm functional units into the SC processes (Schrader et al. 2012)

Learning and growth The learning and growth perspective describes the infrastructure necessary for the achievement of the objectives. It includes information required for new products developed, new markets entered, Research and Development (R&D) spending/sales, training/sales, and investment/total assets/capability development. (adapted from Figge et al. 2002)

4. Current concerns

The concept of PM in SCRM has been explained separately within the SSCM literature, which highlights the dire need of exploring the interplay between the two. Within the literature, the most commonly used conceptualization includes the strategic level performance measures, that views performance as an ultimate or long-term consequence of SCRM (Simangongson et al. 2012) i.e., neglecting the role of short-term PM. Nevertheless, the process level measures are also viewed as antecedent of SCRM (Munir et al. 2020). In doing so, the PM tools, concepts, instruments play the role of facilitator or enablers. As mentioned, the presence of performance in SCRM has been discussed but the idea of conceptually linking the two sides of the coin is relatively new. For example, a container of 500 Ion Lithium batteries ordered from company A situated in China by company B, in Germany, through marine ports. Since the temperature is one of the crucial measures to check the likelihood of getting fire during shipment, the company B strives to monitor the temperature during shipment using their PM system. While reaching B, the measurement system showed the company B that the temperature of the container is close to exceeding the set measure thereby indicating a likelihood of disruption risk. Now, without a proper measurement system or the set performance indicator, in this case, temperature, how would a company be able to detect a fault?

Taking the same example, suppose the container caught fire, now the next step is how to mitigate the risk that has been occurred. The company can check for internal capacity i.e., use either the social capital, e.g., alternative suppliers or ad-hoc partners or check the warehouse stock to fulfill the customer demand. Having a measurement system indicating all the warehouse stock and nearest alternative suppliers can then determine the effectiveness of the company's response to the risk occurred. Therefore, embedding PMs into the risk management play a vital role in reducing and mitigating risk effects. This requires exploring the two concepts in detail and then linking them in such a way that is beneficial for mangers, in particular, and supply chains, in general.

4. Performance measurement for risk management in developing countries

Globalization has brought developing regions into perspective. With the changing paradigms of today's world, measuring performance of supply chain processes and actors in these regions have become more important for various reasons. First, increasing focus on sustainability measures put pressure on the companies to ensure sustainability of the entire chain. For the upstream performance in the developing regions, related indicators can curb the sustainability risks. For example, most of the developing regions are crucial part of resource-based global supply chains (Silvestre, 2015). Making sure the practices in these upstream supply chain actors conform to the mission of the company so to avoid reputational losses thereby posing financial

risks. Second, offshoring poses threat of opportunistic behavior which is difficult to determine. Having a PMs based on the indicators such as “quality” and “trust” etc can ensure the integrity of the first and second tier suppliers thereby reducing the probability of risk occurrence. For example, suppose a company is under pressure to quickly start off-shoring, primarily due to short-term focus of bonus incentives, this can lead to inadequate quality check of second tier suppliers. If not checked the likelihood of such supplier for suppling defective wires is high. These wires are then used by manufacturer and get integrated into a range of appliances. The defective wire then causes the appliances to malfunction. The cost to fix this quality lapse includes replacement of defective appliances, including installation costs, reworking the existing appliances stocked at different levels in the supply chain, and reworking the goods in the three-week long pipeline as they arrived. Therefore, PM for SCRM is an important consideration when organizations devise plans for emerging economies regions.

Considering the “consumer-oriented” and “inclusive business-practices” arguments of the emerging economies literature (Tate et al. 2019), it is evident that measurement of quality and trust play a crucial role in overcoming the risks associated with the two, respectively. Highly uncertain environments of these markets further stress the need for short-term PM which should be well aligned with the risk management strategies of the firms. If considered, it can help in successful implementation of strategies and improve visibility which are two critical components for risk management. Nevertheless, developing countries are important in this context as their market environment is considered highly uncertain and riskier also because of the presence of institutional voids (Parmigiani and Rivera-Santos, 2015). Therefore, it is crucial to devise and incorporate PM for risk management throughout the supply chain.

5. Emergent Concerns, Outstanding Research, and Future Directions

Striving for a better performance while successfully managing the risks is the core point of a firm’s existence, in particular, and supply chain, in general. The inter-play between the two demands more understanding of the conceptual linkage. For the said purpose it was crucial to explore the literature on PM and SCRM. PM comprises the PM tools, systems, concepts, instruments, and indicators which are further categorized based on their focus (Aman and Seuring, 2021a; Beske-Janssen et al. 2015; Schaltegger et al. 2014). Within risk management, conceptualization requires details on the risk factors, management practices, and control and monitoring. Therefore, a complete risk management debate is provided by explaining how PM can influence and be influenced by SCRM.

Moreover, various factors have been suggested that can influence decisions that are particular to the supply chain risk. The conceptual definition of the performance characteristics

has been presented and most common risk and related strategies have been identified, hence, consideration of their inter-play can affect the strategic outcomes of a firm. As indicated, PM both before and after devising risk management strategies is found critical for risk management. Therefore, understanding this role and its successful implementation can help managers in detecting early diversion from the set performance targets.

There are some directions for discussion and development of the topic especially from scientific, theoretical, and/or research investigation perspective. First, which PM tools, concept, systems and instruments and indicators are linked to which risk and which risk management strategy? This highly depends on the company's values as well as vision statement. Linking the two better in such a context require company's mangers to consider long-term aims of the company, consequent strategies and accurately linking them with short term performance measures ensure that the maximum risk can be avoided. Nevertheless, these PIs for risk management can further be devised for internal, upstream, downstream, and reverse logistic activities as well as actors using the measurement instruments, tools suggested.

Second, the PIs vary from company to company and should be the focus the focal firms. For example, the PIs for food supply chains would be different from the automotive supply chains and that of the apparel supply chains. However, some of the PIs mentioned in the chapter can be applied to all these supply chains and adding more specific indicators based on the companies' strategic objectives need to be discussed further by the researchers.

Third, what behavioral aspects can cause risk and PM problems? There is always a risk of opportunistic behaviors, however, incorporating collaboration as a strategy and relative incorporation of collaboration themed balance score card can ensure that the risk can be avoided. Still researchers can test this proposition in real world setting. It would be insightful to understand what behavioral aspects can cause what type of risks and how measurement of these indicators minimize the risk of subsequent negative outcomes. Similarly, what other contingency factors do a company need to consider while linking risk and performance measures? Exploring further contingency factors would help both the practitioners and researchers in understanding the interplay between the two.

Lastly, how digitization facilitates linking risk and PM? Recent disruption risk faced from COVID-19 enforced the supply chains to incorporate digitization of the existing supply chain activities. Digitization can ease the PM and help in swiftly managing the associated risks. Taking the example of 500 Ion Lithium batteries, suppose the company was using sensors in container to check the temperature and a digital assistant to check PIs and upon any diversion, an alarm was set to alert the managers for potential risk of fire in the container. The mangers

would quickly try to resolve the related risk such as delay of order by checking the internal capacity of the company through digital assistant. Besides, with the evolution of digitization and digital components such as big data and Internet of Things (IoT), a company can harness web analytics for more informed performance measures to exploit in reaching the performance outcome (Järvinen and Karjaluoto, 2015) as it provides the real time visibility (Ivanov and Dolgui, 2020). Therefore, digital PM or selection of performance measures from the use of digital components holds several ideas for future studies.

6. Managerial implications

The managers and policy makers can consider these performance and risk factors in strategical decision-making regarding risk management. These factors are also extracted from sustainability perspective, so to incorporate financial, environmental, and social factors together into their PM. The strategic performance outcomes reflect on the company's vision statement and the process level measures reflects on the mission statement, where PM tools, systems, instruments facilitate the measurement of the latter to monitor and control the risk for the achievement of former.

7. Summary and Conclusion

Building on the notion that there is a dearth of understanding on the interplay between performance and risk, the chapter intends to explain the current state of performance in SCRM. It further elaborates on this by presenting a comprehensive understanding of the performance considering the PM literature. In doing so, the chapter addresses the previously sought comprehensive view on the antecedent and consequences of SCRM. The role of SCPM within SCRM is presented as a loop which can be explored further by taking individual performance instruments, tools, concepts or indicators and their role in SCRM. One such example includes role of social capital in SCRM. The chapter concludes that there are many PM constructs that can serve as antecedents and consequence in SCRM which still require future research in its own right

3. Interestingly it's Innovation: Reviewing Sustainability Performance Management in the Base of the Pyramid (BoP)

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Abstract

While the relevance of business and supply chain processes in base of the pyramid context is much discussed, the link to performance measurement (PM) has not been clarified. Focusing on sustainable supply chain performance measurement (SSCPM), this paper provides a literature review to determine which PM tools, instruments, and indicators (PIs) have been used in the base-of-the-pyramid (BoP) literature and how they are associated with sustainability performance outcomes. Exploring SSCPM allows identifying key PIs (KPIs) considering all three dimensions of sustainability: social, environmental, and economic. A structured content analysis on 91 selected papers was performed, and the results interpreted using frequencies and contingency analysis. The core factor driving performance was found to be innovation. The findings suggest that the PIs used in the analysed BoP literature are primarily conventional, leaving a gap in the understanding of the sustainability perspective. The BoP literature also lacks an appropriate PM instrument and discusses predominantly specific indicators of these instruments, showing that research at the intersection of sustainable supply chain management (SSCM) and SCPM demands further development. Nevertheless, incorporating innovation into the PM system informs BoP policymakers to understand better how performance objectives can be achieved in BoP contexts.

Keywords: supply chain management, sustainability, performance measurement, base of the pyramid, BoP

1. Introduction

The term base or bottom of the pyramid (BoP) was coined by Prahalad and Hart (1998), from which the research stream focusing on BoP communities emerged (Prahalad and Hammond, 2002). From its dominant consumer focus (BoP 1.0) to its producer-oriented (BoP

2.0) economic activities, BoP research is dedicated to empowering impoverished communities by seeking novel and innovative solutions for them (Lim et al. 2013; Gold et al. 2013; London et al. 2010; Ahlstrom, 2010; Karnani, 2007). Adding the local community to supply chain (SC) activities requires close monitoring of their performance to maintain a smooth flow of materials and information along the chain so that the focal firms can achieve their targets. It is also important to surveil the performance efficiency because the BoP environment comprises informal markets that are geographically dispersed and have the poor infrastructure (Silvestre and Neto, 2014). Therefore, to attain goals in BoP markets, it is crucial to keep track of the efficiency of the business process.

SC performance measurement (SCPM) research defines efficiency using various performance measurement (PM) instruments, tools, and specific performance indicators (PIs). Based on these, a focal firm can measure the performance of an entire chain (Maestrini et al. 2017; Neely et al. 1995). The tools that are used range from conventional ones, which includes PIs such as cost or quality to sustainability such as life cycle assessment based (LCA) (Zhu et al. 2019) and social and environmental standards (Hall et al. 2014; Huber et al. 2018). Consequently, measuring performance in terms of conventional and social and ecological dimensions is regarded as a sustainability or triple-bottom-line (TBL) approach.

As discussed, the aim of implementing a PM system is to attain higher performance outcomes, which is also a primary aim of any firm (Ahi and Searcy, 2015). BoP markets also offer several performance benefits, for example, profitability and corporate social responsibility (CSR) returns for both local and international firms (Hall et al. 2014; Ramani and Mukherjee, 2014). Therefore, if a firm is aiming to achieve high sustainability performance targets, it is crucial to understand what performance measures drive these outcomes; hence, this paper covers both conventional and sustainability SC performance measures and how they are interlinked in BoP literature.

Moreover, the intersection of sustainable SC management and PM offers key PIs, and the sustainability performance of an SC can be monitored based on these. However, research on this intersection is mainly discussed in the Western context (Ahi and Searcy, 2015), thereby highlighting a gap in understanding which sustainability performance measures are useful in developing or BoP countries (Khalid et al. 2020). Furthermore, the intricate relationship between the prominent process PIs and strategic performance outcomes also needs to be analysed because this intersection is either explored in Western-context empirical settings—for example, Luzzini et al. (2014) and Hald and Ellegaard (2011) or in literature reviews, it is only

mentioned in descriptive forms or future research agendas (e.g., Maestrini et al. 2017). Therefore, two research questions (RQs) are addressed in this study:

RQ1: What are the key PIs employed in the BoP literature?

RQ2: What is the interrelationship between performance process and outcome measures within the BoP–SCM literature?

First, a brief conceptualisation of PM, along with examples from the BoP literature, is presented. Second, the research methodology used for the structured literature review employing content analysis is explained; a frequency analysis is conducted to address RQ1, and contingency analysis is used for RQ2. Third, the findings of the frequency and contingency analysis are presented in detail. Fourth, the findings and limitations are discussed. Finally, the significant results are summarised in conclusion.

2. Conceptual foundation

2.1. Supply chain performance measurement

Any firm's strategy is motivated by its objectives, its ultimate goals or outcomes (Elaydi and Harrison, 2010, Dewangan and Godse, 2014). The performance management literature suggests that the strategic choice of putting PM systems in place is intended to ensure that the firm's objectives can be achieved (Aguinis, 2009). This is specifically important for the BoP discourse, where the performance of the firms has been criticised due to several challenges ingrained in these communities, whether it be geographical dispersion of facilities or opportunistic behaviours of the actors therein (Silvestre and Neto, 2014). Therefore, the measurement of performance would proffer a better picture and detect an early diversion from the performance targets, which in turn help in the achievement of a firm's strategic performance outcomes in the BoP context (Dewangan and Godse, 2014).

Furthermore, the evolution of performance outcomes from conventional such as sustainable competitive advantage, financial performance (Arzu and Erman, 2010) to sustainability such as environmental and social performance (Das, 2018; Saeed and Kersten, 2017; Gold et al. 2013; Seuring and Müller, 2008) can be found in the literature. The sustainability performance outcomes (i.e., economic, social, and financial), sustainable competitive advantage and operational outcomes that have been used so far are presented in Table 1 below.

Table 3.1 Performance outcomes

Outcome PIs	
Economics/business performance	Financial gains yielded from a business activity—that is, profitability, revenue, and economic growth.

	The endpoint of the cause-and-effect relationship.
Sustainable competitive advantage	It is achieving and maintaining a competitive advantage as a result of business activity.
Operational performance	Cost reduction, speed, time, flexibility, dependability, output quality achieved, new quality product developed.
Social performance	Social benefits achieved as a result of a business activity—poverty alleviation, empowerment, inclusiveness, and so on.
Environmental performance	Environmental benefit achieved as a result of business activity—that is, energy consumed, waste produced, improved air quality, and so on.
Sustainability development	Development of all three dimensions of sustainability: social, economic, and environment, i.e., not focusing on performance outcome of a single dimension.

SCPM can be defined as "a set of metrics used to quantify the efficiency and effectiveness of supply chain processes and relationships, spanning multiple organisational functions and multiple firms and enabling SC orchestration" (Maestrini et al. 2017, p. 301). The above definition illustrates a broad meaning of PM, which is often found limited in its further exploration (e.g., Saeed and Kersten, 2017; Maestrini et al. 2017). In the above definition, the PM metrics can be derived from various measurement systems, tools, and instruments. The literature further distinguishes between these tools, systems, and instruments based on their focus. The PM tools can be categorised as instruments, system, or concepts (Beske-Janssen et al. 2015). Whereas the PM instruments have a narrow focus and are categorised as indicators, labelling, reporting etc. (Beske-Janssen et al. 2015; Schaltegger et al. 2014). Other examples of instruments include benchmarking (Grafland et al. 2004), auditing (Owen et al. 2000), and lead-time reduction (Hult et al. 2002). These PM instruments are further analysed through specific PIs. The literature further distinguishes between the PIs included in these PM instruments based on their tangible and intangible characteristics (Hervani et al. 2005).

First, the tangible indicators include those of LCA, such as greenhouse gas (GHG) emissions and waste production, which are used to observe growth or decline patterns in SC processes (Cai et al. 2009). These tangible process measures/indicators are measured directly (i.e., numerically) and the literature suggests that they should be used to assess the efficiency of SC processes (Beske-Janssen et al. 2015).

The intangible indicators are also present in the PM literature. These performance measures are determined by the effectiveness of SC processes (Maestrini et al. 2017), such as customer satisfaction, trust, and commitment. For example, trust is a non-numerical measure that can determine the reliability of the relationship between two SC actors. Because this relationship cannot be directly assessed, the actors assume trust in each other if they adhere to the standards that they set mutually, such as those required for ISO certification (Gold et al. 2013). Therefore, these measures are labelled as output measures, and they hold intangible characteristics.

In sum, the efficiency measures have tangible characteristics while output measures hold intangible characteristics (Hervani et al. 2005). This is also in line with the definition of performance in the general performance management literature (e.g., Aguinis, 2009). In conclusion, an efficient PM system is the one which includes both these forms of performance measures. Therefore, the study incorporates both these forms of performance measures; these will be referred to as process indicators or process measures in the following sections (Table 2).

Table 3.2 Descriptions of performance measures

Terminology	Subcategories	Type of Measures	Definition	Reference
Performance	Process performance (Process level measures)	Efficiency measures	These are the directly measurable set of metrics, and they refer to the strategy that the firm is expected to use—for example, a financial strategy referring to the BSC perspective.	Aguinis, 2009; Figge et al. 2002
		Output measures	These are the indirectly measurable metrics, and they are determined by the effectiveness of the SC processes and hold non-numerical characteristics—for example, customer satisfaction and trust.	Aguinis, 2009; Maestrini et al. 2017
	Outcome performance (Strategic level measures)	Outcome measures	These are "the endpoint of cause-and-effect relationships referring to the other financial BSC perspective."	Figge et al. 2002, p. 270.

In the past, performance has been used in a variety of ways, from measuring process performance to determining outcome performance (Table 2) and from conventional to sustainable performance. At the intersection of sustainability SC dimensions and PM, one finds sustainable SC performance measurement (SSCPM), which can be defined as a set of metrics that are used to quantify the efficiency and effectiveness of SC processes and relationships by considering all three dimensions of sustainability: economic, social, and environmental spanning multiple organisational functions and multiple firms and enabling SC orchestration. Therefore, all three dimensions of sustainability are considered for the content analysis.

2.2. Sustainability performance measurement and the base-of-the-pyramid discourse

The PM scope in the BoP literature includes performance management focusing on internal business processes (Hernandez-Cazares et al. 2019), suppliers (Koster et al. 2019), customers (Ahrens et al. 2019), and multi-tier SC (Agnihotri, 2013). Measuring performance at different nodes of the SC is crucial, especially in the BoP discourse, because of the geographical dispersion of the SC actors in the BoP markets (Silvestre and Neto, 2014). Therefore, the PM

scope and the PIs used therein facilitate the smooth flow of SC processes. This is evident from the systematisation of Maestrini et al. (2017), which is explained in Table 3.

Table 3.3 PM scope by Maestrini et al. (2017).

SC Performance Measurement Scope	
Internal	
Internal	The "monitoring and control of the processes that take place within the firm's boundaries" (Maestrini et al. 2017, p. 301).
External	
Supplier performance management (efficiency, effectiveness, relational)	A "set of metrics measuring the efficiency and effectiveness of suppliers' actions and the goodness of the relationship with them" (Maestrini et al. 2017, p. 301).
Customer performance management (efficiency, effectiveness, relational)	A "set of metrics measuring the efficiency and effectiveness of customers' actions and the goodness of the relationship with them" (Maestrini et al. 2017, p. 301).
Multi-tier	"An evolution of first-tier supplier and customer PMS, extending the measurement to additional downstream or upstream actors" (Maestrini et al. 2017, p. 301).
Many to many (third party)	"A set of metrics used to quantify both the efficiency and the effectiveness of inter-firm processes shared by multiple buyers and multiple suppliers" (Maestrini et al. 2017, p. 301).

Furthermore, the conventional performance measures from various PM instruments can be found in the BoP literature (Howell et al. 2018). Similarly, measures from the Supply Chain Operation Reference (SCOR) model have also been found in the BoP literature i.e., cycle time (Beckett et al. 2020), cost (Adegbile and Sarpong, 2018), service quality (Saul and Gebauer, 2018) and asset (Heuër, 2017). However, these performance measures in the BoP literature are mostly used apart from the PM systems, tools and instruments, which makes them rather scattered from a performance management perspective. Since PM plays a central role in detecting the deficiencies in the performance of supply chain processes, it becomes even more crucial to know what measures should be given preference and how measuring them can derive better performance outcomes for BoP. Therefore, the list of performance measures offered by Maestrini et al. (2017) promises to be relevant for BoP discourse. This is a comprehensive set, that can be expected to cover related aspects in a broad manner, allowing us to identify what has been covered so far as well as point to research gaps. It includes measures/indicators from the conventional SCPM perspective using three instruments such as Balanced Score Card (BSC), SCOR model, and Resource-Output-Flexibility (R-O-F) (Table 4).

Table 3.4 List of constructs by Maestrini et al. (2017) used for content analysis and their description.

Performance Measurement Instruments and Tools
BSC Measures

Financial	The *financial perspective* indicates whether the transformation of a strategy leads to improved economic success. Financial performance is defined as a strategy rather than an end point of the cause-and-effect relationship. (Figge et al. 2002)
Customer	"The *customer perspective* defines the customer/market segments in which the business competes. By means of appropriate strategic objectives, measures, targets and initiatives the customer value proposition is represented in the customer perspective through which the firm/business unit wants to achieve a competitive advantage in the envisaged market segments" (Figge et al. 2002, p. 271).
Internal business process	"The *internal process perspective* identifies those internal business processes that enable the firm to meet the expectations of customers in the target markets and those of the shareholders" (Figge et al. 2002, p. 271).
Learning and growth	The *learning and growth perspective* describes the infrastructure necessary for the achievement of the objectives. It includes new products developed, new markets entered, Research and Development (R&D) spending/sales, training/sales, and investment/total assets/capability development. (adapted from Figge et al. 2002)
Supply Chain Operation Reference (SCOR; attributes to consider in accordance with plan-source–make–deliver) Model Measures	
Cycle time	"Cycle time refers to the time it takes from initiation to completion of the purchasing process" (Hult et al. 2002, p. 580).
Cost	Cost is usually a monetary estimation of effort, material, resources, time and utilities consumed, risks incurred, and opportunity forgone in the production and delivery of a good or service—that is, cost-efficiency. (Adegbile and Sarpong, 2018)
Service quality	"Service quality includes two dimensions; the first dimension deals with procedures and specific systems which are established to provide the service, while the second is personal and concerned with the interactions among workers and their attitudes and behaviours with customers" (Al-Saa' da et al. 2013, p. 45).
Asset	Asset attribute refers to the effectiveness of asset utilisation measured in terms of cash-to-cash cycle time, return on fixed assets, and return on working capital. (Heuër, 2017)
R-O-F Measures	
Resources	Resource measures include both tangible and intangible resources, such as capital requirement, inventory levels, personnel requirements, and equipment utilisation. (Schuster, 2014)
Output (customer satisfaction/expectation)	Various dimensions of customer service are reported. Output measures include customer satisfaction measured through return on the quantity and quality of the products being produced and customer expectation through being more considerate and responsive to customer demand. (Viswanathan et al. 2012)
Flexibility	Flexibility refers to how easy it is for an SC to change based on its range of options. (Ahren et al. 2019)

Furthermore, the TBL approach has also provided a sustainability lens for widespread performance management (Khalid et al. 2015). The BoP literature points towards sustainable PIs several times. One such example includes, "companies have been incorporating sustainability into business performance measures. Multinational corporations (MNCs) codes of conduct help to increase quality and speed of operations, which in turn allows code-operating companies to receive more orders and increase revenue" (Jia et al. 2018, p. 272). Here, the code of conduct (i.e., corporate citizenship) is a process performance measure; however, operational and financial performance are outcomes. Moreover, the evolution of the BoP literature asserts

the importance of learning and local community engagement in the value-creation process while focusing on the achievement of the outcomes from the economic (Hall et al. 2014; Arnold and Williams, 2012), social (Halme et al. 2012; Kistruck et al. 2011), or environmental (Rebehy et al. 2017) perspectives. Some researchers suggest ways to improve overall sustainability (Kolk et al. 2014) and to achieve global competitiveness (Berger et al. 2011). Therefore, various sustainable PIs exist in the BoP literature, and it is vital to understand which sustainable performance measures have been considered thus far and how they facilitate sustainable performance outcomes.

Further, the incorporation of PM tools is necessary because the BoP literature has used them to link with various economic and business performance outcomes (e.g., Koster et al. 2019) for example, linking environmental management systems (EMSs) with social performance (Heuër, 2017). The list offered by Beske-Janssen et al. (2015) covers PM constructs (i.e., tools, systems, instruments) from all three dimensions of sustainability (i.e., social, environmental, and economic) and is, therefore, both comprehensive and relevant to the BoP discourse, a list of sustainable PM constructs is provided in Table 5.

Table 3.5 List of constructs by Beske-Janssen et al. (2015) used for content analysis and their description.

Performance Measurement and Management Tools	
Environmental Instruments	
Eco-audit	"Eco-auditing is also applied to methods of describing the state of the environment and environmental impact analysis [...]. [...] the management approach, evaluating to what extent the organisation complies with internal and/or external environment requirements" (Aall, 1999, p. 152).
Environmental (Env.) benchmarking	"Through benchmarking, companies are given a mark for their actions and achievements, which enables stakeholders to judge how responsible a specific company is" (Graafland et al. 2004, p. 139).
Env. reporting	"[This is the] process of communicating the environmental effects of organisations' economic actions to particular interest groups within society and society at large" (Nitkin and Brooks, 1998, p. 1499).
Economic Instruments	
Financial report	This is an annual report published by companies that tells society at large about the companies' financial situation, including profit or loss for particular periods (Nitkin and Brooks, 1998).
Social Instruments	
Social audit	A "social audit attempts to provide a mechanism for decision-makers to evaluate economic and social planning, facilitate popular involvement in economic decisions and identify the social need as a primary criterion for resource allocation" (Owen et al. 2000, p. 83).
Social benchmarking	"Through benchmarking, companies are given a mark for their actions and achievements, which enables stakeholders to judge how responsible a specific company is" (Graafland et al. 2004, p. 139).
Stakeholder dialogue	"In the dialogue with stakeholders (both primary and secondary) opinions are exchanged, (future) interests and expectations are discussed, and standards are developed with respect to business practice" (Kaptein and van Tulder, 2003, p. 208).
Social reporting	This is the process of communicating the social effects of organisations' economic actions to particular interest groups within society and society at large by publishing reports (Nitkin and Brooks, 1998)

Corporate citizenship	"At a minimum, corporate citizenship means the conduct of business in ways that reflect proactive, responsible behaviour in business and dealings with all constituents and with respect to communities, society, and the natural environment more generally" (adapted from Logan et al. 1997, p. 7).
Sustainability Instruments	
Sustainability audit and monitoring	Sustainability auditing refers to characteristics such as suppliers' compliance with the measurable standards that are employed to assess environmental management, the use of a trained audit team, and the organisation's release of progress reports. Sustainability monitoring includes the evaluation of suppliers by auditors vis-à-vis ability to meet measurable standards and improving the flaws by training them. (Seuring et al. 2019)
Sustainability benchmarking	"Through benchmarking, companies are given a mark for their actions and achievements, which enables stakeholders to judge how responsible a specific company is" (Graafland et al. 2004, p. 139).
Sustainability reporting	"One trend that is also apparent in many parts of the world is the tendency of companies to produce separate social and environmental reports. In this context, such reports are generally termed as CSR reports or sustainability reports, depending upon the development of the corporation concerned" (Aras and Crowther, 2009, p. 283).
Sustainability SCPM Instruments	
Social LCA Indicators	
Gender diversity	This refers to the consideration of gender diversity in the life cycle of a product. "It is the proportion of males to females in an organisation that can affect the way in which they interact and behave with one another at the workplace, and thereby impact the social and cultural environment" (IGI Global, 2020).
Human rights	This refers to the consideration of human rights in the life cycle of a product. Human rights include the right to life and liberty, freedom from slavery and torture, freedom of opinion and expression, the right to work and education, and many more. Everyone is entitled to these rights without discrimination (United Nations, 2020).
Local community commitment (LCC)	This is the consideration of the local community in the life cycle of a product. LCC means taking the long-term views and embeddedness of firms in local communities into account to deal with the local contestations for survival that filter into the everyday lives of the poor (Ansari et al. 2012)—for example, social inclusion.
Fair trade	This is the consideration of fair trade in the life cycle of a product. Fairtrade means that the producers receive prices that cover their average costs of sustainable production, the premium which can be invested in projects that enhance social, economic and environmental development (Fairtrade International, 2019).
Fair labour	This is the consideration of fair labour in the life cycle of a product. "This includes paying less than the minimum wage, employing young children, and working employees for long hours without premium overtime pay" (Goldstein et al. 1999, p. 1003).
Child labour	This is the consideration of child labour in the life cycle of a product. "A child (5–14 years) is defined as economically active if he or she works for wages (cash or in-kind); works on the family farm in the production and processing of primary products; works in family enterprises that are making primary products for the market, barter or own consumption; or is unemployed and looking for these types of work" (Edmonds and Pavcnik, 2005, p. 201).
Environmental LCA Indicators	
Waste production	This is the consideration of waste production in the life cycle of a product: the production of unwanted materials as a by-product of economic processes (Sustainable Development Indicator Group, 1996).
Greenhouse gas (GHG) emission	This is the consideration of GHG emission in the life cycle of a product for example, CO_2, SOx, and NOx. The emissions of harmful gases into the air is

	called air pollution because they alter the chemical composition of the natural atmosphere. (adapted from Daly and Zannetti 2007)
Noise pollution	This refers to the consideration of noise pollution in the life cycle of a product. Noise pollution is generally defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms (Environmental Pollution Centres, 2019).
Recycling	This is the consideration of recycling in the life cycle of a product. Recycling means the processing of waste (i.e., unwanted or useless materials) and its (re)introduction back into the material cycle so that contamination of the environment is minimised. (Tanskanen 2013)
Pollution	This is the consideration of pollution in the life cycle of a product. Pollution is the introduction of harmful materials into the environment which further damage the quality of air, water, and/or land. (adapted from Daly and Zannetti 2007)
SCPM Systems	
Quality Management System	A management system which uses the ISO quality certificates for managing the quality of the products. (Beske-Janssen et al. 2015)
Environmental Management System (EMS)	"ISO defines an EMS as 'that part of the overall management system which includes organisational structure, planning, activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing, and maintaining [the organisation's] environment policy" (ISO, 1996).
Social Management System	A management system which includes the social ISO certificates for managing the social impact and also includes the occupational health and safety system (OHS). (Beske-Janssen et al. 2015)
Integrated Management System	A management system which uses integrated managing tools such as Global reporting initiative and UN global impact (Beske-Janssen et al. 2015)
SCPM Standards	
Quality standards (ISO 9001)	"ISO 9000 is about quality systems and consistency. It aims to give customers confidence in their suppliers by assuring them that the suppliers have in place management processes that deliver consistency. It encourages but does not of itself directly assure product quality" (Terziovski et al. 1997, p. 1).
Env. standards and certificates	An EMS helps companies reach the same standards in their business operations using similar policies and standards for environmental protection (Huber et al. 2018).
Social certification	Social certificates are a coordinated and systematic approach to managing health and safety risks by maintaining social standards such as OHS; SA8000; OHSAS 18001 (WorkSafe Victoria 2020)
Sustainability standards	These refer to the standards or rules, procedures, and methods used to systematically assess, measure, audit, and/or communicate the social and environmental behaviour and/or performance of firms (Gilbert et al. 2011)

Additionally, PIs, which were observed quite frequently in the BoP literature, i.e., relational PIs and innovation (Rosca et al. 2019), were also included in the study. The indicator such as innovation can be found in the PM literature where it has been used in accordance with the SCOR model (Bai et al. 2011; Huan et al. 2004). Similarly, relational PIs includes the relational dimensions that could help better inform the desired performance outcome. The relational PIs cover social capital (Rosca et al. 2019), trust (Mahapatra et al. 2019), commitment (Seuring et al. 2019), and integration (i.e., supplier, buyer) (Brewer et al. 2019). These measures are

observed very frequently and separately in the BoP literature (Rosca et al. 2019). Opportunistic behaviour has been pointed out several times as one of the significant challenges in the BoP literature (Gold et al. 2013), thereby making the presence of relational indicators quite evident. Therefore, including these indicators in the PM systems is necessary for BoP performance outcomes. Similarly, performance management researchers have introduced trust as a metric into the collaboration-themed scorecard (Kaplan et al. 2010), thus making it a part of the BSC. Due to their relevance, in both BoP and PM literature, these measures (see Table 6) are also incorporated into the content analysis as process PIs.

Table 3.6 Additional performance indicators

Additional PIs (Emerging from the BoP literature)	
Social capital	Social capital is defined as those features of social structures—such as levels of interpersonal trust and norms of reciprocity, mutual aid etc—which act as resources for individuals and facilitate collective action.(Nahapiet and Ghoshal, 1998)
Trust	The degree of reliability enjoyed between the SC partners which also facilitates SC processes (Al-Saa'da et al. 2013)
Commitment	Commitment may be defined as the relative strength of an individual's identification with and involvement in a particular organisation (Steers, 1977)
Supplier integration	Integrating suppliers into the SC processes (Schrader et al. 2012)
Buyer integration	Integrating buyers into the SC processes (Schrader et al. 2012)
Innovation	Innovation is the setting up of a new production function. This covers the cases of a new commodity and new ventures—that is, an organisation or a merger—or the opening of new markets, new relationships, new products, or new marketing infrastructure (Schumpeter 1939; Hall et al. 2014)

3. Research methodology

3.1. Data selection and gathering

The BoP sample papers were chosen using the scientific search engine Web of Science (WOS). The user-friendly interface and extensive data set offered by WOS made it the perfect platform from which to gather related articles. Only peer-reviewed papers published in the English language between 2012 and 2020 were accepted; the selection of only peer-reviewed papers confirms the quality of the articles that were selected for the analysis. The data-gathering process is presented in the Figure 1 below:

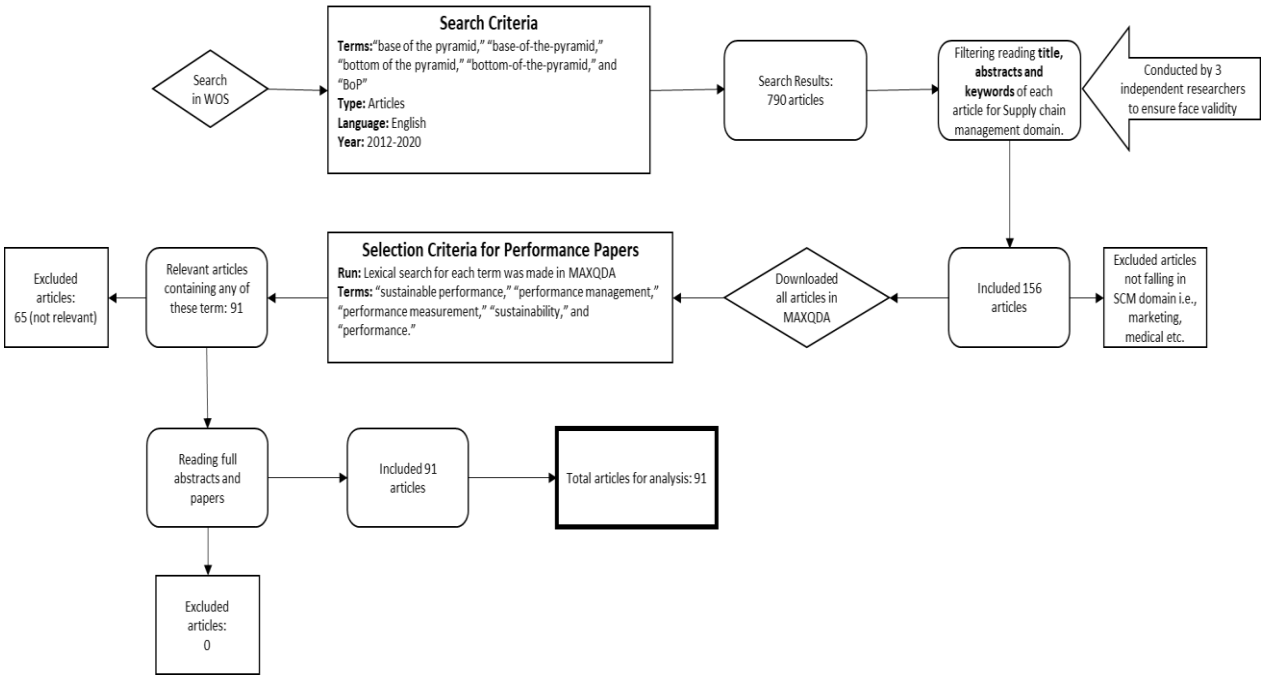

Figure 3.1 Data gathering process

First, the terms "base of the pyramid," "base-of-the-pyramid," "bottom of the pyramid," "bottom-of-the-pyramid," and "BoP" were used to gather BoP-related literature only. The initial result from the WOS database identified a total of 790 articles from diverse fields of study. These articles were then reduced by analysing their titles, abstracts, and keywords for SC management domain. The articles falling within the SC management domain were further shortlisted. This process was undertaken by three independent SC management researchers, who later combined their findings to reach a consensus regarding the shortlisted articles; this ensured face validity. As a result, 156 articles were selected and downloaded in MAXQDA, a qualitative data analysis software. Among these articles, the performance papers were selected using MAXQDA's "lexical search" feature, which allows users to search for specific strings in the downloaded documents. Searches were conducted individually for terms such as "sustainable performance," "performance management," "performance measurement," "sustainability," and "performance." Only 91 papers used one or more of the above terms and were considered for the subsequent analysis.

3.2. Content analysis

In general, a literature review is a methodology that is recommended for anchoring a research idea in the body of existing knowledge (Wilding et al. 2012). Literature reviews are often considered essential when a study aims to identify gaps by analysing a large sample of scientific papers related to a particular topic (Fink, 2014). For example, the aims of this study are to

establish the current state of research on SSCPM and the BoP literature and to identify the gaps therein so that suggestions for future studies can then be made. It is defined as "a systematic, explicit, and reproducible design for identifying, evaluating and interpreting the existing body of recorded documents" (Fink, 2014, p. 6). Therefore, a systematic literature review is employed.

The content of the selected literature was analysed following a content analysis approach and includes definitions (of SCPMs and performance), boundaries and limitations (papers selected using keyword searches; 91 papers identified), variables and causalities (categories developed deductively from SCPM models), and predictions (a proposed framework to test in empirical settings; indicators to be used in the measurement of BoP SC performance); this approach is in line with the arguments of Seuring et al. (2020).

The categories applied in a deductive analysis need to be determined beforehand (Mayring, 2015). This approach also allows the researchers to apply open coding and to use existing codes (Mayring, 2015), which helps to incorporate additional constructs that emerge during the review process (see Table 6 for additional PIs).

Deductive performance measures from non-BoP SC performance papers—that is, Maestrini et al. (2017) and Beske-Janssen et al. (2015)—offers a good starting point for the research at hand. These two papers were selected because of recent and extensive literature reviews on PM. Maestrini et al. (2017) provide an extensive list of performance measures based on various PM instruments devised over the years—for example, the BSC and the SCOR model. However, the list focuses only on conventional SC measures (Table 4). Therefore, to cover the sustainability performance measures, a systematic review by Beske-Janssen et al. (2015) was used and analysed in the BoP context (See Table 5). As discussed, the list of PIs offered by these papers is also relevant to the BoP literature and was used for content analysis.

The content analysis involved the following steps:

1. Conducting a keyword search for each performance construct (from Tables 3, 4,5 and 6) in the downloaded documents.
2. Evaluating the construct focus in each downloaded paper—that is, the main focus of the article or customary mention of the indicator.
3. Interpreting the role of the PI as a process or outcome variable.
4. Assigning a code of 1 to the article which mentions the indicators and fulfils the above criteria and 0 to the article which either not mentions or only customarily mentions an indicator.

Furthermore, a data set was created using Microsoft Excel, which was later used for statistical analysis. The statistical analyses were performed for two main reasons. First, a literature review should also involve quantitative elements—that is, frequencies and contingencies—to ensure the robustness of the qualitative findings and to increase the validity and reliability of the analysed content (Mayring, 2015; Seuring et al. 2020). Second, there is an explicit requirement for frequency analysis to answer RQ1 and contingency analysis to answer RQ2; therefore, frequency and contingency analysis were conducted.

3.3. Frequency analysis

Based on the content analysis of each of the 91 papers, a frequency analysis was conducted as per Mayring's (2015) approach. He defines frequency analysis as "filtering out certain textual elements with the help of a category system" to make conclusions about "statements/predictions on the relative importance of these textual elements per frequency/rate" (Mayring, 2015, p. 65). However, the frequencies of occurrences in scientific papers alone cannot predict the associations among the constructs; thus, a contingency analysis was conducted.

3.4. Contingency analysis

A contingency analysis detects a positive association between the categories of the data being analysed. It presents pairs of categories which occur relatively more frequently together in one paper (Gold et al. 2010). This allows for a more in-depth interpretation of the findings than frequency analysis alone.

Calculating the phi coefficient (φ) is a common way to determine the level of association between two categories (Fleiss et al. 2013; Gold et al. 2010). In line with Gold et al. (2010), the value of $\varphi \geq 0.3$ indicates a significant association between the analysed categories. Due to the small size of the sample (91 scientific papers), a one-tailed Fisher's exact test was conducted to eliminate the risk of approximation errors. Only the associations with a one-tail significance and the values rounded to one decimal place were included for further interpretation. The significant contingencies facilitate the interpretation of the pattern observed and the current state of the analysed literature. These contingencies also highlight how particular indicators are interlinked and offers a blueprint for researchers to test in empirical settings.

To establish the inter-coder reliability (ICR) of the data, two or more researchers analysed the same content individually and later combined their findings to calculate the number of times they predicted the same category (Mayring, 2015). Two researchers independently conducted the coding process (i.e., 0 and 1) of 52 papers, and an inter-coder reliability of 74 % was established, a substantial acceptable value for any ICR lies between 0.69-0.80 (Nilli et al. 2020). Later, 39 papers were coded by a single researcher.

4. Findings

The findings of the study are separated into descriptive, frequency, and contingency analysis.

4.1. Descriptive analysis

The descriptive analysis informs about general patterns observed in the analysed sample. This information comprises the deployed methodologies, the years of publication in the time frame between 2012 and 2020, and the scientific journals.

The case study methodology remains the most used methodological approach within the BoP literature (47 papers, 51.65%), followed by conceptual or theoretical research (20 papers, 21.98%). Other scientific papers have applied literature reviews (8 papers, 8.79%), surveys (15 papers, 16.48%), and action research (1 paper, 1.1%). However, to date, the mathematical model as a methodological lens has not been considered in the BoP literature, which is in line with other papers in the field (Khalid et al. 2017), and is a sound representation of BoP-related research.

The analysed sample comprises 91 scientific papers, which are unevenly distributed across the time frame—that is, from 2012 to 2020 (Figure 2). The time frame is of particular interest because a sudden spike in BoP research was observed during these years (Khalid et al. 2017). Forty-three of these papers were published from 2012 to 2014 due to several calls for BoP research in journals—that is, the *Journal of Business Research (JBR)* and *Journal of Business Ethics (JBE)*. Between 2015 and 2017, only 14 papers in the sample were found based on our criteria, and 34 papers were found between 2018 and 2020; this is because of recent calls in the *International Journal of Physical Distribution & Logistics Management (IJPDLM)* and *Journal of Business Logistics (JBL) and Business & Society*. The performance-related aspects of BoP research seem to have been found relevant between 2012 and 2014; this reflects the research interests of BoP researchers. Further, as this is a specific sub-sample of the overall BoP-related research, some of the variations might be due to the random distribution of research topics. Hence, this rather random distribution might be a consequence of the combination of keyword-based searches and variations in the topical coverage of BoP-related research and the calls from various journals.

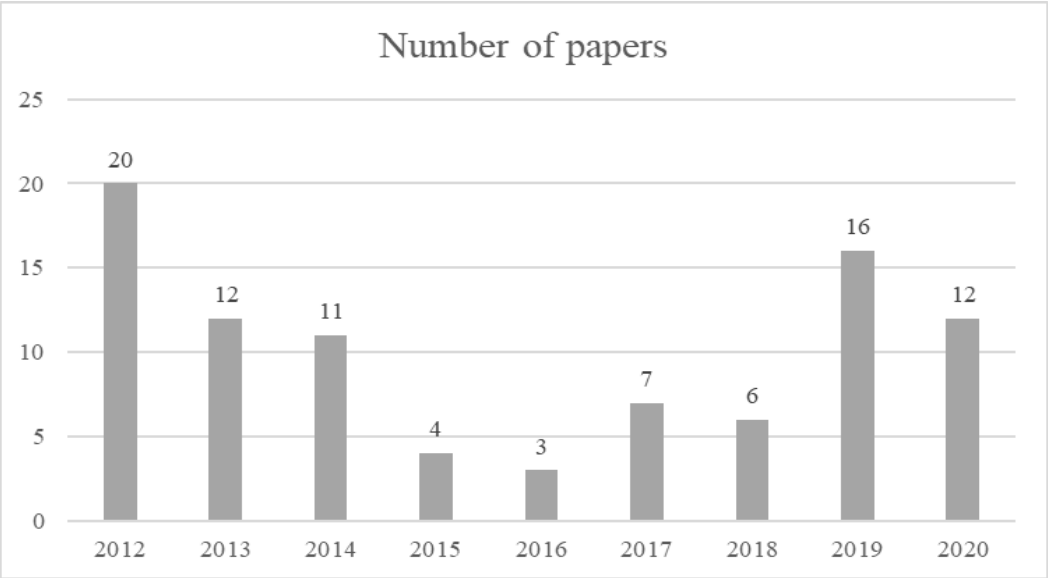

Figure 3.2 Year-wise distribution of the BoP performance papers.

Furthermore, SSCM and BoP performance are focused on in a variety of different journals, for example, the *Journal of Cleaner Production*, *Journal of Business Research* (*JBR*), *International Journal of Physical Distribution & Logistics Management (IJPDLM)*, and *Technovation* (Table 9, see Appendix). The *Journal of Cleaner Production* has the highest share of articles on the topic under study; it is followed by the *JBR*.

Moreover, the regional focus of the articles in the sample is quite diverse; the main focus is on the regions with impoverished communities. The share of Asian countries is the largest, with India being mentioned most frequently—that is, in 52 papers—followed by China and Bangladesh, with 25 and 23 papers, respectively. The articles focusing on Africa are mainly distributed between Kenya, South Africa, Ghana, and Uganda, with 25, 18, 12, and 11 papers, respectively. Central and South America emerged as the third most frequently observed region; the most studied countries in this region are Brazil, Mexico, Peru, and Bolivia with 23, 11, 6, and 6 papers, respectively. The country-specific focus is well in line with the observations made in other papers in the field (Kolk et al. 2014); therefore, the sample is relevant (Figure 3).

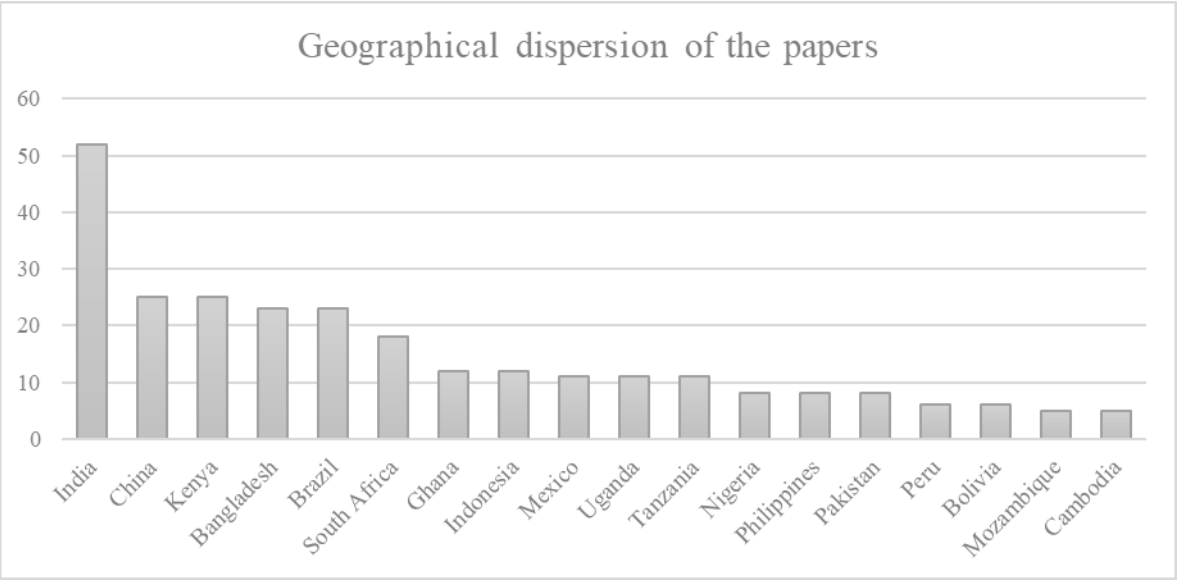

Figure 3.3 Geographical dispersion of BoP literature

4.2. Frequency analysis

Supply chain performance measurement scopes

Forty papers in the analysed literature (43.96 %) cover the internal scope of the SC, followed by the supplier and customer performance management scopes; however, the former was mentioned slightly more frequently in 44 papers (48.35%) and the latter in 35 (38.46 %). The multi-tier scope (i.e., downstream and upstream SCPM focus) was observed in a few articles (16 papers, 17.58%). Finally, the many-to-many scope was mentioned only once in the analysed papers, pointing to an already-existing research gap (Figure 4).

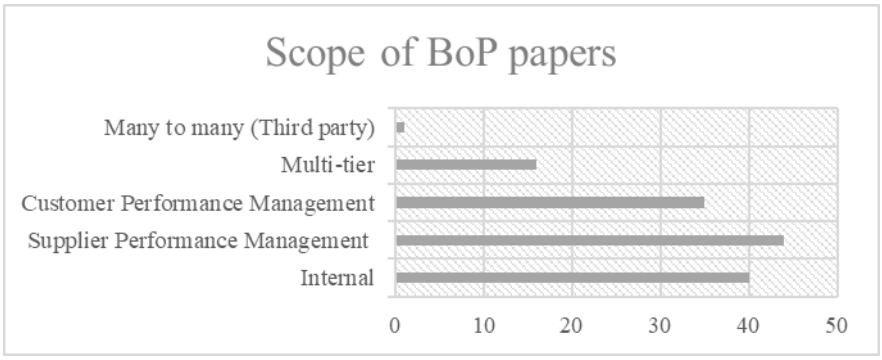

Figure 3.4 Performance measurement scope

Frequencies and the base-of-the-pyramid literature

In general, the most observed PM indicators are the conventional ones captured in Maestrini et al.'s (2017) framework. The subcategories of the models, presented in Tables 4 and 5, were analysed most frequently within the BoP context. However, the BSC was covered in one of the BoP articles—that is, London and Anupindi (2012). Additionally, Bendul et al. (2017) covered

the dimension of the SCOR model. The most frequently mentioned subcategories are compiled in Table 7.

Learning and growth, innovation, resources, cost, and output (customer satisfaction/expectation) are among the most frequently mentioned categories in the BoP literature (e.g., Murphy et al. 2012; Prahalad, 2012). Learning and growth entail the process of learning from the BoP communities about their needs and offering learning opportunities to local producers to improve their living standards. Consequently, the learning process involves mutual growth opportunities and facilities for enhancing performance in the BoP markets (Hall et al. 2014; Ansari et al. 2012; Bardy et al. 2012; Murphy et al. 2012). The learning process requires a long-term focus on the firms; in the BoP literature, this is often referred to as disruptive innovation (Hall et al. 2012; London and Anupindi, 2012; Van den Waeyenberg and Hens, 2012). Furthermore, learning about the needs of the poor facilitates the frugal innovation process (Howell et al. 2018; Ray and Ray, 2011). Frugal innovation involves producing new and cost-efficient products for BoP consumers (Howell et al. 2018). Therefore, innovation was the most frequently mentioned PI (60.4 %); it plays a crucial role in the success of a BoP venture (Berger and Nakata, 2013; Ansari et al. 2012; Bardy et al. 2012) and therefore links this analysis well with the innovation and BoP-related literature (Hall et al. 2014).

Further, the relationship between the SC actors is also a critical factor when it comes to achieving success in these markets. Relationships based on trust are essential to fostering the smooth flow of information and material between SC actors (Scott, 2017; Hahn and Gold, 2014; Shivarajan and Srinivasan, 2013). The literature also focuses on supplier integration (Gold et al. 2013; Ramachandran et al. 2012; Reficco and Márquez, 2012; Schrader et al. 2012), buyer integration (Schrader et al. 2012), and commitment (Schuster and Holtbrügge, 2014). Therefore, relational PIs are the second most frequently covered topic in the BoP literature.

Table 3.7 A list of most frequently mentioned constructs in the BoP literature

Performance	**Exemplary references**	**Frequency count (%*) (N = 91)**
Process performance measures		
Innovation	Murphy et al. 2012; Hall et al. 2014	60.4
Customer	Adegbile and Sarpong, 2018	51.6
Resources	Schuster, 2014	50.5
Cost	Ramani and Mukherjee, 2014	50.5
Output (Customer satisfaction/ expectation)	Viswanathan et al. 2012	42.9
Financial	Gold et al. 2013	41.8
Learning and Growth	Ansari et al. 2012; Bardy et al. 2012; Berger and Nakata, 2013	40.7
Trust	Hahn and Gold, 2014; Scott, 2017; Shivarajan and Srinivasan, 2013	29.7

Supplier Integration	Gold et al. 2013; Ramachandran et al. 2012; Reficco and Márquez, 2012; Schrader et al. 2012	25.3
Buyer Integration	Schrader et al. 2012	19.8
Sustainability audit and monitoring (Supplier evaluation)	Gold et al. 2013	19.8
Gender Diversity	Arnold and Valentin, 2013	18.7
Local Community Commitment	Scott, 2017	18.7
Social Capital	Ansari et al. 2012	17.6
Commitment	Schuster and Holtbrügge, 2014	15.4
GHG Emission	Arnold and Williams, 2012	11.0
Outcome performance		
Operational Performance	Jia et al. 2018, Nakata and Weidner, 2012	38.5
Economic/Business performance	Zhu et al. 2019	31.9
Social Performance	Brix-Asala et al. 2016	25.3
Sustainability development	Gold et al. 2013	23.1
(Sustainable) Competitive Advantage	London and Anupindi, 2012	22.0
Environmental Performance	Hirmer and Cruickshank, 2014; Brix-Asala et al. 2016	12.1

*Percentage values > 10%

Further, the findings demonstrate that the environmental performance measures as both process and outcome were observed relatively less frequently than social and economic measures. Moreover, social process performance measures, such as gender diversity (Arnold and Valentin, 2013) and LCC (Scott, 2017), were frequently found in the sample. Fair labour and human rights (Arnold and Valentin, 2013) were explicitly indicated several times, while the other categories were covered only habitually. Similarly, social performance as an outcome was indicated quite frequently (e.g., Brix-Asala et al. 2016).

The integrative sustainability performance dimension, such as sustainability audits and monitoring, covering supplier evaluation and improvement, is mentioned a few times (Gold et al. 2013). However, none of the articles reported on the actual implementation of these standards in the BoP markets.

In sum, Maestrini et al.'s (2017) conventional PIs are found more frequently in the literature than the sustainability instruments and indicators suggested by Beske-Janssen et al. (2015). The sustainability management tools and instruments are indicated only a few times (Gold et al. 2013). Further, performance outcome—that is, operational performance—yields the highest frequency, followed by economic/business performance. However, the social dimensions are found more frequently as process indicators than performance outcome. Therefore, the results are in line with the argument that the ultimate goal of a firm is to achieve business performance (Yawar and Seuring, 2018), and in the attempt to do so, several sustainability dimensions need to be satisfied.

4.3. Contingency analysis and synthesis of the literature

The contingency analysis conducted for this research indicated some associations between the constructs (Tables 3, 4, 5 and 6), and based on this, a framework was devised (Figure 5). This framework is further discussed in the subsequent sections.

Table 3.8 Observed contingencies among constructs.

Contingencies	Phi-Value	Significance Level	Exact Sig. (1-sided)
Resources * Sustainable Competitive Advantage	0.27*	0.011	0.008
Output (Customer expectations /satisfaction) * Operational Performance	0.26*	0.014	0.011
Output (Customer expectations /satisfaction) * Financial Performance	0.27*	0.011	0.011
Output (Customer expectations /satisfaction) * Innovation	0.27*	0.011	0.010
Innovation * Sustainability performance	0.29**	0.005	0.004
Resources * Innovation	0.26*	0.014	0.014
Operational Performance* Resources	0.26*	0.012	0.011

**p < 0.01

*p < 0.05

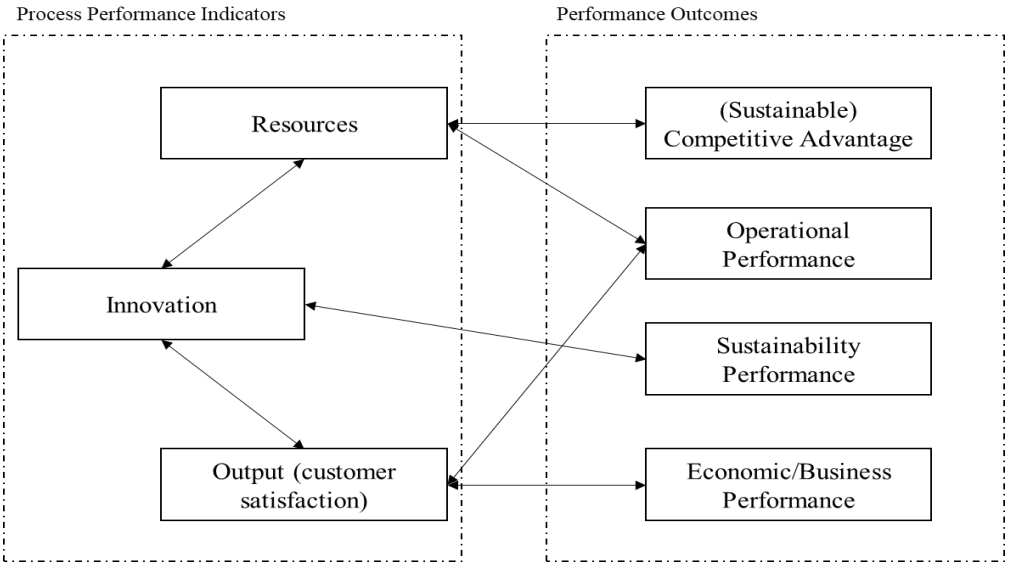

Figure 3.5 Contingencies among constructs

As shown in Table 7 (Frequencies) and Figure 5 (Contingency framework), innovation emerged as a central concept in the BoP literature. Therefore, we can conclude that innovation is a key PI (KPI) in the BoP literature. As previously mentioned, this is in line with a good share of the BoP-related literature that focuses on innovation (Hall et al. 2014; Murphy et al. 2012).

Companies which strive to incorporate novel and innovative solutions into SC activities are likely to excel in these markets. These novel and innovative solutions should be reflected in the source, make, and deliver processes of the SC (Wan et al. 2015; Bai et al. 2012; Shepherd and Gunter, 2006) and should be measured to keep track of an SC success (Schaltegger et al. 2014); whether it be social innovation to source material from geographically dispersed underprivileged farmers (Varadarajan and Kaul, 2017) or to make frugal innovative products—that is, low-cost multiple-use household items (Bals and Tate, 2018) or innovation in delivering to consumer markets (Duarte et al. 2019). Therefore, the BoP environment fulfils the criteria of an innovative ecosystem, which is defined as "an evolving set of actors, activities, and artefacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors" (Granstrand and Holgersson, 2020, p. 1).

Similarly, a contingency between innovation and sustainability performance has been observed (i.e., 0.29). The BoP literature suggests that innovation is linked to all three dimensions of sustainability: social (Ramani and Mukherjee, 2014), economic (Zhu et al. 2019), and environmental (Dembek et al. 2018). However, it is worth noting here that the contingency shows only the association between innovation and broad sustainability outcome. One explanation for that could be that the primary aim of innovation at the BoP is to consider the needs of the poor. To satisfy that need, the BoP firms incorporate new ways which can proffer a rather economical product and service. So, innovation in the characteristics of the products and services must consider the use of factors of production, their environmental spillovers, and the social dimensions associated with them (Kaplinsky, 2011), thereby satisfying the social, environmental, and economic aspects of the products sustainability concept. Since these aspects' consideration drives the BoP context's innovation, the link between the two is quite evident. Moreover, by bringing this change to enable poverty reduction through contribution to growth, innovation itself can be used in a variety of ways. Therefore, not only implementing but measuring innovation is crucial for attaining high sustainability targets. Similarly, each part of the contingency framework will be discussed in the subsequent sections.

Innovation, output (customer expectation and satisfaction), resources, and operational performance

A contingency between innovation and output (customer satisfaction and expectation) has been observed (i.e., 0.27). Similarly, a contingency between innovation and resources has also been found (i.e., 0.26). The contingencies highlight two main value-creation aspects which are also in line with arguments regarding frugal innovation at the BoP (Borchardt et al. 2020).

Ventures which focus on technology improvement by keeping in mind the needs of poor customers are more likely to achieve sustainable development through disruptive innovation at the BoP (Hart and Christensen, 2002). However, arising from affordability challenges, the consumption constraint in the BoP markets demand that companies support frugal innovation. Therefore, the pursuit of disruptive yet frugal innovation initially satisfies the poor's needs and has the unique potential to provide cost-efficient and eco-friendly products to already saturated markets in the West (Hart and Christensen, 2002). Hence, a contingency is found between customer satisfaction and operational performance (i.e., 0.26).

Furthermore, the local stakeholders having technological legitimation for innovation play an integral role in the achievement of multinational enterprises' (MNEs) goal (Hall et al. 2014). These stakeholders are the local human resources who have knowledge that is necessary for the frugal innovation process. The companies which seek top-of-the-pyramid (ToP) resources also require complementary in-house resources to manage the cost of frugal innovative products—for example, TATA motors (Lim et al. 2013). The resource-constrained BoP environment necessitates the identification of resources (both internal and external) and requires that they be used frugally in the achievement of operational goals. Therefore, a contingency is found between resources and operational performance (i.e., 0.26).

Customer satisfaction, customer expectation, and economic/business performance

A contingency between output (customer satisfaction and expectation) and business performance has been observed (i.e., 0.27). Strategic innovation approaches focusing on customer expectation—for example, innovative pricing strategies and innovative distribution/marketing strategies, such as door-to-door selling and billboards—can increase firms' value and profitability (Anderson and Markides, 2007). Thus, the companies which pursued innovation in developing economies by bringing in innovative new products that created new businesses and opened new markets were able to generate growth (Ahlstrom, 2010). This links the BoP-related research to a kind of standard assumption in any market—that is, no business will survive in the long run if customer expectations are not met, and economic performance will not be achieved.

Resources and (sustainable) competitive advantage

A contingency between resources and (sustainable) competitive advantage has been observed (i.e., 0.27). BoP markets are being described as resource deficient in terms of developing radically cheap products to meet the demands of low-end consumers. This requires tangible (i.e., human capital) and intangible (i.e., knowledge) resources from ToP markets, MNEs, or BoP markets which are sometimes crucial for growth purposes (Hall et al. 2012; Lim

et al. 2013). The acquisition and use of new resources from the ToP or the frugal use of BoP resources in such a way that it offers unique products which are hard to replicate leads to a sustainable competitive advantage (Hart, 1995).

5. Discussion

The study addresses a gap in the BoP literature by incorporating insights from the SSCPM literature. The study offers a conceptualisation of process performance measures (i.e., process level) and performance outcomes (i.e., strategic level) and establishes links between them by exploring the BoP literature. These links show the focal firm's role in accepting the sustainability impacts they bring to society (Ramani and Mukherjee, 2014; Gold et al. 2013). Continuously measuring and monitoring these impacts can help detect early diversion from the performance targets, thereby facilitating timely performance management. The descriptive, frequency and contingency findings highlight various performance measures that the BoP practitioners could incorporate into their PM systems. Thus far, this topic has been analysed systematically, which helps explain the contribution of this paper to the BoP literature.

The BoP literature criticises the BoP practices and offers solutions for better understanding and implementing the change in these settings. Therefore, reviewing the literature for performance measures deems as a reasonable approach in addressing the research questions. The crucial role of sustainability performance measures has been observed in the BoP literature. However, the BoP literature is somewhat limited in explaining all three sustainability PM aspects individually. Findings of the frequency analysis show that the majority of the literature emphasises either social or economic measures of the TBL. The environmental frequency (12%) indicates the presence of environmental concerns in the BoP literature and the researcher's interest in addressing them. However, it is still in its early phase. Furthermore, the link between innovation and sustainability performance suggests that the ventures aiming at BoP's innovation to tap international markets later should consider eco-friendly products. The stakeholder pressure for environmentally friendly products is considerably higher in the developed world than in BoP markets. This is regarded as disruptive innovation, and it has been rhetorically discussed in the BoP literature (Hall et al. 2014). Disruptive innovation initially taps the BoP needs, thereby satisfying the operational, economic, and social aspects, and then moves to the markets in the West to offer innovative yet sustainable products, and the BoP literature highly suggests that these markets offer innovative ecosystems (Granstrand and Holgersson, 2020; Hart and Christensen, 2002). Therefore, measuring innovation considering all sustainability factors is necessary for the firm's goal of achieving sustainability performance.

Furthermore, innovation is also sometimes described as institutional innovation, which means innovation in the "collaborative ties" between the partners (Calton et al. 2013). However, the existence of both formal and informal or non-business BoP partnerships (Varga and Rosca, 2019) poses a built-in risk of opportunistic behaviour on the supplier end (Karamchandani et al. 2011). Therefore, establishing trust is necessary for the smooth flow of operations along the chain. The scenario entails the presence of relational PIs in the BoP literature, and these relational PIs are also frequently mentioned (Table 7). Moreover, measuring these collaborative ties using a "collaboration-themed BSC" (Kaplan et al. 2010) can help in monitoring the performance of these relationships even if they are geographically dispersed. This will initially confirm the trust enjoyed between the actors and help trigger early performance diversion from the targets by detecting the opportunistic behaviours therein.

Finally, the emergence of innovation as a process PI and the recent trend towards this in BoP-related studies (Table 7) necessitates the need to explore how innovation can be monitored in diverse industrial settings to tap its efficiency. BoP SC actors choose to pursue different forms of innovation depending on their organisation's objectives; hence, the PM tools and instruments used to measure innovation may differ along the chain and among industries. Because the findings show that innovation is linked to various performance outcomes, adding innovation into the PM systems would help BoP practitioners achieve their performance objectives. Nevertheless, this study offers a contingency framework (Figure 5) which serves as a blueprint for prospective studies to test in empirical settings.

Similarly, the paper also offers a good starting point for an elaborated debate on the link between innovation and sustainability since innovation has emerged as the most widely and frequently used BoP construct. Future studies can explore the link between different types of innovation and sustainability. For example, innovation associated with the characteristics of the product, its environmental spillover, factors of production and collaborative ties involved in manufacturing would help understand the innovation more deeply and comprehensively. Besides, empirical results would contribute to the understanding of both BoP academics and practitioners alike. Therefore, the paper thoroughly explains how innovation has been perceived thus far in the BoP literature and emphasises the inclusion of innovation in PM tools and instruments such as BSC, SCOR model etc.

The research also has several limitations. The analysis comprises 91 articles due to selecting specific keywords, but the sample size is large enough to yield interesting insights. With regard to theory, the adoption of a deductive approach limits the number of constructs to be analysed. However, the advantage is that a more in-depth assessment is enabled, allowing for insights

beyond the obvious. Moreover, simultaneous incorporation of inductive codes allows analysing the prevailing debates in the literature, which was previously limited by deductive coding, thereby drawing the benefits from both approaches. In this respect, a higher degree of external validity is reached, and the missing link between sustainability, SCPM, and the BoP-related literature is established. Adding more constructs inductively also balanced the approach that is taken; therefore, innovation as a key topic emerging in the analysis proved to be highly relevant in the overall analysis. The framework proffered is based on the BoP literature only i.e., taking BoP articles as the unit of analysis, this can be further tested in empirical settings. Nonetheless, most of the articles analysed used an empirical methodology (i.e., 69%), thereby justifying the practical relevance of the study. Finally, the role of process performance measures as efficiency and output is explained in the conceptualisation section solely to justify their incorporation into the study, but because of the complexity involved in their assessment, which is also beyond the scope of this study, they are not explicitly explored.

6. Conclusion

With the aim of investigating the KPIs in the BoP SCs and linking sustainability process performance measures and sustainability performance outcomes, this research offers several insights. The findings show that the BoP literature discusses only the subcategories of the PM tools and instruments. Moreover, the presence of relational performance measures, such as social capital and trust, indicates their importance in the smooth flow of material and information along the BoP SCs and suggests that they should be incorporated into the PM instruments. Further, by focusing on customer expectations and resources, innovation as a central performance process measure can enhance economic or business performance and competitive advantage for the BoP SCs. Therefore, BoP firms need to incorporate innovation into their PM system, such as the SCOR model, to tap its efficiency. Furthermore, future research on sustainability PM needs to explore which PM tools and instruments should be used to measure innovation and how. This can also be done in a specific industrial setting—for example, the food SC—and can extend the knowledge base of academics and practitioners alike.

4. Sustainability Performance Measurement in Risk and Uncertainty Management: An Analysis of Base of the Pyramid Supply Chain Literature

This chapter represents a prospective journal article by the author, Stefan Seuring and Raja Usman Khalid. It is in preparation for *Business Strategy and the Environment.*

Abstract

Risk management in the base of the pyramid (BoP) environment is needed to ensure that firms performance objectives are met. Accordingly, integrating sustainability performance measurement in the supply chain risk management would offer interesting avenues for managing risks in BoP supply chain. Therefore, the paper conceptualizes an intersection between supply chain risk/ uncertainty management and sustainable performance measurement. This intersection is then tested by a literature review of 108 BoP SC articles between the years 2000 and 2019. Descriptive, frequency and correlation analysis identify various risks factors studied in the BoP literature so far, their management strategies and respective performance measures. The findings show a broad strategical aspect of managing SC risks; and proffered the tactical or operational level performance measures which along with these practices can manage the related risks. Therefore, their incorporation into the risk management process should be considered. The correlation findings highlight the important role of performance process measures and the impact of these along with the management practices on firm's performance outcomes. The study contributes to supply chain risk and performance management literature by capturing the nexus between BoP and supply chain management.

Keywords - supply chain risk management, sustainability performance measurement, sustainable supply chain, performance, base of the pyramid (BoP)

1. Introduction

The primary aim of any firm revolves around achieving the overall performance targets. With globalization and increasing pressure from the stakeholders for sustainable production (Gouda and Saranga, 2018), firms are compelled to focus beyond their organisational boundaries to achieve their performance targets. Therefore, supply chain management becomes necessary. The idea of boundary-less management has brought in risks that differ in their context and managerial approaches to solve them (Tang, 2006; Simangunsong et al. 2012; Tummala and Schoenherr, 2011; Fan, and Stevenson, 2018). Besides, addressing these risks is

essential since the repercussions of inappropriate risk management become more significant for the performance-related dimensions (Simangunsong et al. 2012; Hult et al. 2010). These performance dimensions range from economic to social to environmental ones (Das 2018), which are often referred to as triple bottom line or sustainability (Khalid et al. 2015). The concerned literature also suggests that 'the sustainability performance management is not often due to direct demand enforced by the legal act but because the companies aim to reduce the related risks' (Seuring and Müller, 2008, p. 1703). Therefore, these two streams of research share several overlaps and integrating them will bring depth in the theoretical understandings (Gouda and Saranga, 2018; Maestrini et al. 2017; Simangunsong et al. 2012; Tummala and Schoenherr, 2011; Arzu and Erman, 2010).

Risk also depends on the environment in which it prevails (Tang, 2006). The BoP environment or the prevailing conditions of informal markets expose firms to various risks. For example, London and Hart (2004) posit that the BoP markets are associated with unique challenges, whereas Alvarez and Barney (2006) describe it as an environment with a high level of uncertainty. Similarly, the institutional context of these markets often provides little support for economic activities (Khanna and Palepu 2005). Non-existent formal capital markets, an uneducated workforce, poorly developed public infrastructure (Zomorrodi et al. 2019), informal governance mechanisms (Webb et al. 2010), and little or no protection of property rights (Soto 2000) are all characteristics of the BoP context that also make the environment challenging for the firms to operate efficiently. Especially the MNCs or the local producers experience a high level of knowledge and information gap because of the poor development of the business ecosystem (Zomorrodi et al. 2019). Consequently, lack of a proper business ecosystem serves as a barrier for the manufacturing as well as the distribution of the products being produced (Varga and Rosca 2019). Moreover, it is advocated in the BoP literature that the practices introduced there mainly enhance the strategical level understanding of operating in this environment (Khalid et al. 2019). However, incorporating performance measures into the risk management process would enhance specific or tactical level knowledge about the PIs linked to the risk management practices. Furthermore, the PM literature argues ‘that what is not measured is not managed’ (Manuj and Mentzer 2008, p 216). Therefore, integrating PM in risk management would provide a narrative for BoP SCs to operate in this environment successfully and sustainably.

Further, integration of PMS in the risk management process can be found in other management domains such as ‘finance’ (e.g., Weekes-Marshall, 2020). However, the SCM researchers identify the combined importance of risk and performance management in SC and

call for more research in this regard (e.g., Samson and Gloet, 2018; Akwei and Zhang, 2018). Consequently, to address these gaps in the literature, the current study aims to develop a risk management framework for BoP environment by integrating sustainability performance measures.

Therefore, the broad research question taken up for the study is.

- RQ: How supply chain risk management has been dealt with in the BoP literature?
    - RQ1: Which risk factors are prevalent in BoP literature?
    - RQ2: Which risk management strategies are frequently used in BoP literature?
    - RQ3: Which sustainability performance measurement dimensions are frequently used in BoP literature?
    - RQ4: Which risk management strategies are linked to performance measurement dimensions?

The paper is structured as follow: First, SCRM conceptual framing by sustainability performance measurement literature while explaining its relevance for the BoP literature. Second, the methodology is explained. Third, the paper presents a finding section containing the answers to sub-research questions 1, 2, 3 using frequency analysis and RQ4 by conducting a correlation analysis. These findings are then discussed in subsequent sections, along with the limitations, future directions and implications. Lastly, a conclusion addressing the main research question is made.

2. SCRM Conceptual Framing and BoP Literature

The section starts with a conceptualization of SCRM and the role of sustainability performance measurement therein by taking arguments from SCRM and sustainability supply chain performance measurement (SSCPM) literature. It further presents a selection of the constructs from the SCRM and SSCPM literature. The operationalization of these selected constructs is shown in the Appendix. Furthermore, an outline of BoP-related research along with an intersection of SCRM and BoP research is discussed.

2.1. Sustainability Performance Measurement in Supply Chain Risk Management

It is well documented in the risk management literature that the supply chain risks are managed through a process (Fan and Stevenson, 2018). The risk management process is usually divided into three broad phases, i.e. identification and assessment, evaluation, planning and mitigation, control and monitoring (Tummala and Schoenherr, 2011). The identification, assessment and evaluation of the risks (phase one) can tell the probability and magnitude of

their occurrence alone. Once identified and evaluated, risk management strategies (phase two) are implemented, which then lead to control and monitoring (phase three). Therefore, in order to understand a risk management process, all these things need to be explored which will be done in the subsequent paragraph.

The terms risk and uncertainty are often used interchangeably; however, some authors have argued that both terms have several distinctions as both offer different performance outcomes (Simangunsong et al. 2012; Tummala and Schoenherr, 2011). Tummala and Schoenherr (2011) used uncertain environmental conditions as triggers to certain risks factors. Whereas, Simangunsong et al. (2012) presented sources that can contribute to the uncertain environment. After scrutinizing these two frameworks, the triggers used by the former are overlapped with the sources of uncertainty identified by the latter. Therefore, we have compared these two frameworks to operationalize the identification of the 'risk' phase. These two papers identify the most prevalent risks in the risk management literature such as: demand, supply, distribution, transportation, delay, supplier, manufacturing, capacity, sovereign, and most recently, disruption risk (Chen et al. 2014). These risk factors can also be seen in recent debates, for example, Manhart et al. 2020; Ivanov and Dolgui, 2020; Paul and Chowdhary, 2021, thus making them appropriate for the study.

Further, risk planning and mitigation require a set of strategies that need to be deployed to mitigate related risks. Within the broader prospect of risk management, it is managed at strategical and tactical levels. The strategical level risk is often directed towards the probability of occurrence of a certain event, for which preventive risk strategies could lead to positive outcomes. The practices include the product design, shorter planning period, good decision support system, collaboration decision policy & procedures, use of information communication and technological (ICT) system, pricing strategy, redesign of chain configuration and/ or infrastructure (Manhart et al. 2020; Simangunsong et al. 2012). These practices are devised to reap long term strategic benefits as well as protection against risks (Manhart et al. 2020). The tactical level is linked to the operational level risk and often needs reactive mitigation strategies to reduce their effects on performance (Gouda and Saranga 2018). Most identified reactive mitigation strategies in risk mitigation literature include postponement, volume/delivery flexibility, process flexibility, customer flexibility, multiple suppliers, strategic stocks, lead time management, financial risk management, and quantitative techniques (Moktadir et al. 2021; Ali et al. 2017; Christopher and Holweg, 2017; Tang, 2006; Christopher and Lee, 2004). Therefore, the list offered by Simangunsong et al. 2012 is both comprehensive and relevant for both preventive and reactive risk management strategies.

Once the strategy is decided by the top management to prevent or mitigate a risk then related performance measures are devised to see whether the deployed risk management strategy reaps the intended benefits (Chenhall and Langfield-Smith, 2007). The scenario entails the role of PM in the risk management process and how embedded it is in the management of risk which is also often mentioned in the risk management literature (Gouda and Saranga 2018). Therefore, sustainability efforts are integrated as a later stage after risk management strategies.

The SSCPM literature includes several performance measurements tools as well as specific performance measures, often regarded as control and monitoring tools (Laihonen and Pekkola 2016; Selviaridis and Norrman, 2014), which could be beneficial for the management of risk (Weekes-Marshall, 2020; Seuring and Müller, 2008). For example, such as environmental benchmarking, social reporting, financial auditing etc. These performance tools and measures are the part of performance measurement systems and are frequently discussed in the performance management literature (Arzu and Erman, 2010; Grosvold et al. 2014). The firm can also put these measurement systems in place to monitor the implementation of risk management strategies (Seuring and Müller, 2008; Beske-Janssen et al. 2015). This approach has grounds in strategy and performance measurement literature, where for example a strategy is devised, and related performance measures are proffered by different functional units of an organisation to track or evaluate the success of the implemented strategy (e.g., Chenhall and Langfield-Smith, 2007; Laihonen and Pekkola 2016; Blos et al. 2009). They can be beneficial in triggering the defect in a firm's operations through continuous auditing and reporting of changes once the risk management strategy has been implemented (Arzu and Erman, 2010). Therefore, incorporating these sustainability performance management efforts as control and monitoring of risk strategies is crucial in the risk management process, however it was previously mentioned only as a strategy to prevent uncertainty (Simangunsong et al. 2012).

In sum, conceptualizing risk management is a complex process that requires details on the risk factors, management practices, and performance measurement. Therefore, a complete risk management debate can only be provided if all these phases are explained together (Fig. 1). After extensive scrutiny and cross comparison of various supply chain risk and sustainable supply chain performance literature, we selected four major papers to combine for the purpose of our conceptualization. For the constructs of risk related factors, Tummala and Schoenherr (2011) and Simangunsong et al. (2012) papers were used. Moreover, for performance measurement constructs two performance papers, i.e., Maestrini et al. (2017) and Baske-Janssen et al. (2015) were selected. These two papers were used to capture most of the performance constructs (conventional and sustainable, respectively) used so far in supply chain management

literature and were suggested by experts in the field. How these constructs are also relevant for BoP literature is discussed in the subsequent section.

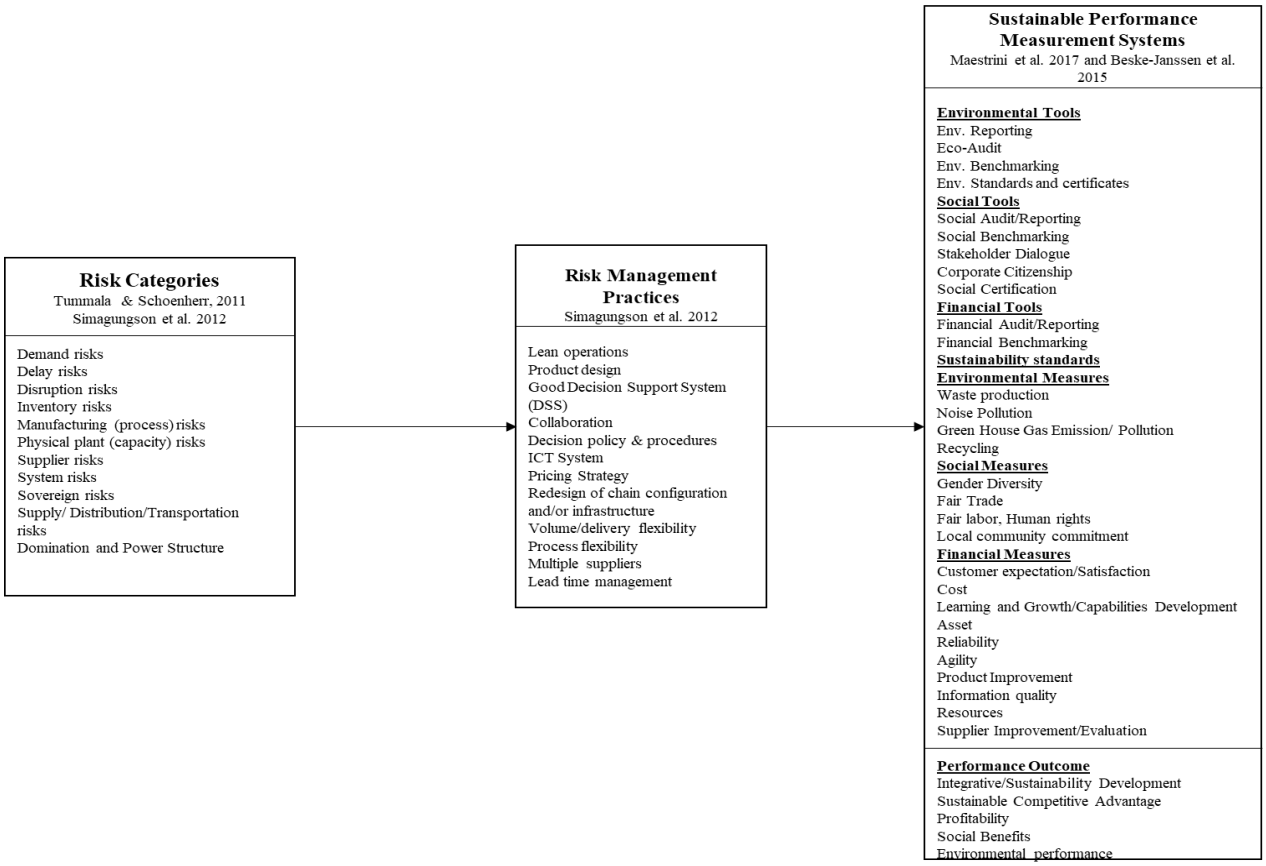

Figure 4.1 Risk and performance management: An overarching logic

2.2. Base of the Pyramid and Supply Chain Risks

The BoP markets seek novel solutions to serve the poor; thus, the usual mindset of national responsiveness may not operate efficiently in these unique markets (Lashitew et al. 2021; Golicic et al. 2020; Alvarez and Barney, 2006). The environment of the BoP is considered unique because it poses challenges of institutional voids, poverty and informal market structures to the firms operating or aim to serve there (Ramachandran et al. 2012; Shivarajan and Srinivasan 2013). These challenges make the BoP environment riskier for the firms to operate efficiently. In the wake of the institutional void, the asymmetrical knowledge, expertise and other resources remain in the hand of a few, which might pose risks for the manufacturing firms (source, make, deliver) in achieving their performance targets (Alvarez and Barney, 2006). Besides, the informal markets and infrastructural challenges make it difficult to procure and disperse the produces to the large base of potential customers, i.e. contributing to the supply

and distribution risk (Varga and Rosca 2019). It might further create barriers to tap the purchasing power and social sustainability ingrained in these communities (Golicic et al. 2020).

Similarly, poverty is one of the significant challenges, contributing to the demand risk, which needs to be addressed for successful operations in these markets. Addressing this issue in wholesome manner requires firms to have a deep understanding of their customer base, their needs, and affordability (Calton et al. 2013). Not only this, implementing the risk management strategies also needs strong monitoring to ensure whether these strategies are helpful in BoP context. Since the geographical dispersion in these markets is evident, the use of performance measurement tools or specific performance measures can help facilitate the process. Therefore, the overarching logic of risk management is similar for the BoP discourse (Fig. 1), and it proffers a perfect contextual lens to develop the risk framework further and provide insights from the emerging or developing economies.

Institutional voids can describe the background or the environment of the BoP markets, but which risk factors are prevalent for the firms in these markets still need further exploration. Research specifically addressing institutional voids has been conducted previously e.g., Parmigiani and Rivera-Santos, (2015) and Rehman et al. (2020), however, the former explicitly addresses the institutional voids and how firms can attain competitive advantage by managing these voids, while latter differentiates between institutional voids and shows its impact on supply chain risks and performance. From the above two, it clear that institutional voids and SC risk offer different concepts, therefore a clear distinction between two has already been established (Rehman et al. 2020). Furthermore, the latter does deal with the performance constructs but does not incorporate performance measurement, i.e., leaving a gap in understanding the SSCPM aspect. Furthermore, the latter paper also neglected the supply chain risk phases, i.e., leaving a gap in the literature, which makes it even more interesting to what extent this overarching risk management logic is applied in the BoP literature.

3. Methodology

In general, a literature review is a recommended methodology to anchor a research idea in the body of existing knowledge (Seuring and Gold 2013). Fink (2019, p. 6) defined a literature review (LR) as "a systematic, explicit, and reproducible design for identifying, evaluating and interpreting the existing body of recorded documents". The aim of the paper is to identify risk, related strategies and performance measures from the existing body of BoP-SCM documents. Besides, it is a sort of a meta-narrative which identifies and understands all potentially relevant

research traditions that are impossible using a meta-analysis effect-size (Snyder, 2019). Therefore, a LR is found to be a suitable method for this study.

The approach also allows the researchers to apply open coding as well as using existing codes, which helps to incorporate additional constructs that emerged during the review process (Miguel et al. 2014). Therefore, an abductive research approach has been undertaken.

Furthermore, the BoP papers were gathered using the Web of Science (WOS) database, which was selected because of the extensive data set of the peer-reviewed journals. Only English language peer-reviewed articles were considered for further analysis because English is the widely understood language in the world.

The analyzed papers were identified employing keyword search in WOS. Initial keywords include 'base of the pyramid', 'BoP' and 'bottom of the pyramid'. This method identified around 790 papers from diverse fields of study. Among these papers, three independent SCM researchers shortlisted the papers particularly falling under the SCM domain and reach a consensus of their inclusion into the content analysis. A total of 136 papers were identified through this approach. Furthermore, a title, abstract, conclusion approach was employed to shortlist papers, particularly addressing risk and sustainability performance. As a result, a total of 108 papers from the year 2000 to December 2019 were selected and mutually agreed upon between 3 researchers to ensure face validity, the approach undertaken is also recommended by various researchers (such as, Snyder, 2019).

After condensing the BoP risk and performance literature, a content analysis technique was employed (Snyder, 2019). The content analysis technique comprises coding of the selected articles on a scale (Mayring 2015). However, standardized means of abstracting appropriate information from each article should be used, such as 'it can take the form of conceptualizations of a certain idea or theoretical perspective' (Snyder, 2019, p. 337). Since the paper uses a conceptualization from the general risk management and performance measurement literature, content analysis is suitable for extracting information from the BoP literature. Furthermore, this approach is often combined with the quantitative analysis techniques such as descriptive, frequency, contingency and meta-analysis (for example, Borman and Dowling, 2008). Therefore, the content of the shortlisted papers for this study was first analysed on a Likert type scale (containing three questions per construct; i.e., Is the construct represented in the paper? Is the construct used as an antecedent to achieve something? Is the construct mentioned as an outcome/endpoint?). The data set was prepared in an excel file afterwards converted to a .csv file to run frequency and correlation analysis in SPSS.

The frequencies show the number of times a construct appear in the relative dataset (Mayring, 2015). Therefore, the results of frequencies alone cannot explain the relationship between the constructs, for which correlation analysis technique was employed (Mayring 2015). The BoP literature provides rich content on risk management. However, the specific focus of the papers was rather diverse. The papers used the constructs in both habitual (i.e., customary mentioning of a construct) and explicit (specifically dealing with the construct) ways. The habitual ways of dealing with a construct often create biases in the results. Due to limited knowledge about the use of constructs, by employing 0 and 1, the constructs may be only assessed superficially, which makes issues in the validity of the data. The point has already been raised by several researchers but never addressed so far (Rehman et al. 2020). Therefore, to address this, an in-depth analysis tool has been formulated to get the in-depth natural essence of the constructs used in BoP literature. It helped in eliminating the chances of adding constructs that were only mentioned habitually in the literature. The findings comprise the spearman correlation coefficient values significant at 0.01 or below. This non-parametric correlation coefficient is also selected because it is appropriate if an ordinal scale is being used. Only significant correlation values were used for the interpretation of the literature.

4. Findings

The findings are divided into three sections 1) Descriptive 2) Frequencies 3) Correlation. Descriptive and frequencies present the current state of BoP literature as per the appearance of selected constructs in the scientific papers. Correlation gives an association between two constructs based on their pattern of occurrence in the analyzed papers.

4.1. Descriptive

First, all the papers were selected based on the richness of their content related to respective constructs. The analysed papers are distributed between the year 2000 to 2019 (Fig. 2).

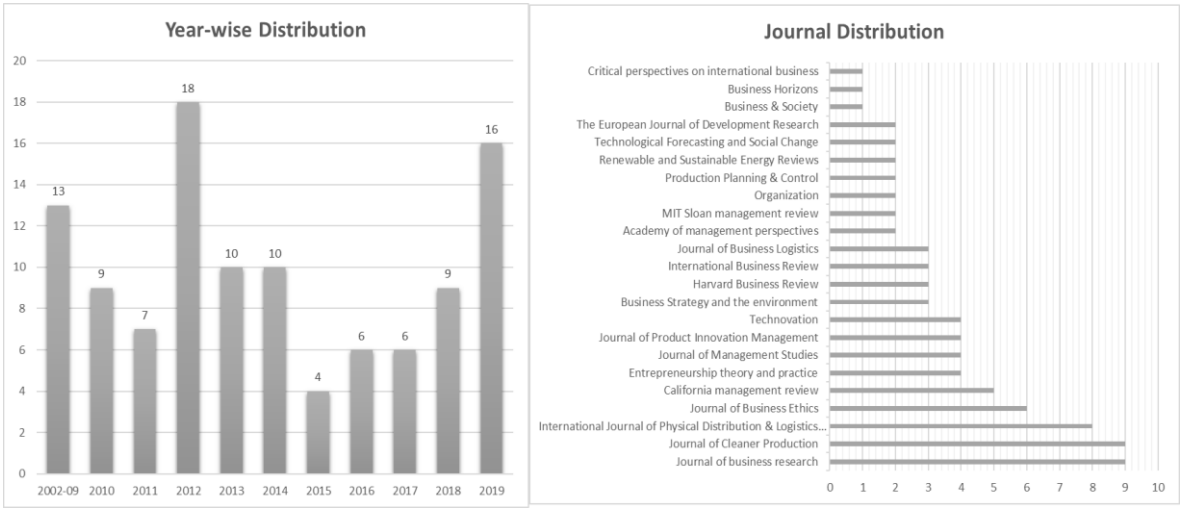

Figure 4.2 Distribution of supply chain papers (Years and Journals) covering the BoP domain.

Figure 2 shows the number of BoP papers appeared in English language peer-reviewed journals during the last decade. Where, the most published papers were in the year 2012, because of the special issues dealing with the subject in the *Journal of Business Ethics* (JBE) and *Journal of Business Research* (JBR). Following a decrease in BoP focus in years afterwards, i.e., reaching the smallest number of papers in 2015, the BoP literature again saw a boost in 2019. It is because of recent calls for special issues in the *Journal of Business Logistics* (JBL) and *International Journal of Physical Distribution and Logistics Management* (IJPDLM). However, the data set is limited to the papers until December 2019. We encourage other researchers to examine the research further to keep the research stream up to date. A list of journals and the number of selected articles is presented in Figure 2.

Lastly, the methodological dispersion among the BoP papers is quite diverse. It mainly comprises the case study methodology (61 papers, 56%), followed by conceptual and theoretical papers (23 papers, 21%). Moreover, survey research (22 papers, 20%) is the third most used methodological lens, only eight papers conducted a literature review (8 papers, 7%), which contributes to the strength of the paper at hand. Any analyzed paper does not use the mathematical models and Delphi-study technique, suggesting a gap in the methodological choices. These findings are in line with previous research i.e. Kolk et al. 2014.

4.2. Frequency Analysis

The focus of the selected papers is varied, such as 86 papers pointed towards the poverty alleviation aspect, 59 papers highlighted the institutional voids whereas, in 43 papers the informal market structure has been discussed. Several overlaps, in their focus, have also been identified. From the risk management perspective, majority of the papers only identified (75 papers, 69.44%) the risks within the BoP environment and suggested that the preventive strategies (70 papers, 64.81%) are the most common strategies for the management of risks

(Table II). Little evidence on the monitoring and control (12 papers, 11.11%) has been found in the BoP literature.

The frequently mentioned constructs, in the identified BoP papers, are presented in Table I. The table provides an overview of the BoP literature with the counted frequencies. The most frequently observed construct is *innovation* with a frequency of 60.19%, followed by *learning and growth and capability development* with a frequency of 52.78%. The next most frequently observed construct is *social capital* with a frequency of 50.93%. Therefore, innovation is viewed as a core element to become successful in BoP markets.

Table 4.1 Constructs used as a basis of content analysis along with the frequencies.

Risk Phases		Frequency (%)
Identification/measurement/ assessment		69.44
Evaluation		44.44
Prevention		64.81
Mitigation		24.07
Control and Monitoring		11.11
Risk Categories	Example from BoP Literature	Frequency (%)
Demand risks	(Anderson and Markides 2007; McMullen 2011)	26.85
Disruption risks	(Hill and Mudambi 2010; Moura et al. 2019)	8.33
Inventory risks	(Moura et al. 2019; Ramachandran et al. 2012)	3.7
Manufacturing (process) risks	(London et al. 2010; Schrader et al. 2012)	5.56
Supplier risks	(Hahn and Gold 2014; Rosca et al. 2019)	12.96
System risks	(Kistruck et al. 2011; Rivera-Santos et al. 2012; Akula, 2008)	28.7
Sovereign risks	(London et al. 2010; Varadarajan and Kaul 2018)	29.63
Supply/ Distribution/ Transportation risks	(Hens 2012; Vachani and Smith 2008)	34.26
Additional Risk Constructs	Example from BoP Literature	Frequency (%)
Investment Risks	(Akula 2008; VanSandt and Sud 2012)	31.48
Domination and Power Structure	(Vachani and Smith 2008)	12.04
Preventive Strategies	Example from BoP Literature	Frequency (%)
Lean operations	(Rebehy et al. 2017)	6.48
Product design	(Ramachandran et al. 2012)	40.74
Good Decision Support System (DSS)	(Berger et al. 2011)	12.96
Collaboration	(Calton et al. 2013; Hahn and Gold, 2014; Rivera-Santos and Rufín, 2010; Rivera-Santos et al. 2012)	50
Decision policy & procedures	(Varadarajan. R 2014)	12.04

ICT System	(Berger, and Nakata, 2013)	17.59
Pricing Strategy	(Karnani 2007)	12.04
Redesign of chain configuration and/or infrastructure	(Rivera-Santos and Rufín 2010; Schrader et al. 2012)	35.19
Mitigation Strategies	Example from BoP Literature	Frequency (%)
Volume/delivery flexibility	(Ahrens et al. 2019)	2.78
Process flexibility	(Ahrens et al. 2019)	1.85
Multiple suppliers	(Rivera-Santos et al. 2012; VanSandt and Sud 2012)	9.26
ICT System	(Howell et al. 2018)	4.63
Lead time management	(Koster et al. 2019; London et al. 2010)	13.89
Performance Measurement Tools	Example from BoP Literature	Frequency (%)
Eco-Audit	(Seuring et al. 2019)	0.93
Env. Standards and certificates	(Gold et al. 2013)	7.41
Social Audit/Reporting	(Seuring et al. 2019)	1.85
Social Benchmarking	(Koster et al. 2019)	0.93
Stakeholder Dialogue	(Calton et al. 2013; Matos and Silvestre 2013)	16.67
Corporate Citizenship i.e sponsorship, CSR, CSE (entrepreneurship)	(Arnold and Valentin, 2013)	25.93
Social Certification	(Koster et al. 2019)	7.41
Environmental Measures	Example from BoP Literature	Frequency (%)
Waste production	(Rebehy et al. 2017; Varadarajan, 2014)	8.33
Green House Gas Emission/ Pollution	(Rebehy et al. 2017; Varadarajan, 2014)	7.41
Recycling	(Rebehy et al. 2017)	6.48
Social Measures	Example from BoP Literature	Frequency (%)
Gender Diversity	(Hens, 2012)	1.85
Human Rights	(Mena et al. 2010)	2.78
Fair Labor	(Arnold and Valentin 2013)	3.7
Local Community Commitment	(VanSandt and Sud 2012)	26.85
Economic/operational/ conventional Measures	Example from BoP Literature	Frequency (%)
Learning and Growth/ Capabilities Development	(Ansari et al. 2012; Lim et al. 2013)	52.78
Asset	(Shivarajan and Srinivasan 2013)	2.78
Responsiveness	(Moura et al. 2019)	8.33
Cost	(Elaydi and Harrison 2010; Lim et al. 2013; Ray and Ray 2010)	37.96
Agility	(Berger and Nakata 2013; Nakata and Weidner 2012)	14.81
Product Improvement	(Ahlstrom 2010)	5.56
Information quality	(Galariotis et al. 2011)	4.63
Resources	(Ray and Ray 2010; Tashman and Marano 2009)	40.74

Customer expectation/ Satisfaction	(Matos, et al. 2019)	28.7
Supplier Improvement/Evaluation	(Jajja et al. 2019)	18.57
Additional Measures (*Outcome)	Example from BoP Literature	Frequency (%)
Internationalization performance/BoP performance*	(Bardy et al. 2012)	21.3
Employee/ Intrapreneuralship	(Halme, Lindeman, and Linna 2012)	6.48
Social Capital	(Ansari et al. 2012; Kistruck et al. 2013; Varga and Rosca, 2019)	50.93
Trust	(Schuster and Holtbrügge 2012; Sutter et al. 2014)	15.74
Commitment (supply chain actors)	(Moura et al. 2019; Vachani and Smith 2008)	17.59
Integration	(Rivera-Santos and Rufín 2010)	28.7
Empowerment	(Ansari et al. 2012)	9.26
Innovation	(Ahlstrom 2010; Halme et al. 2012)	60.19
Mutual Benefits/ Value creation/win-win*	(London et al. 2010)	30.56
Performance Outcomes	Example from BoP Literature	Frequency (%)
Sustainable Competitive Advantage/ Competitiveness	(Anderson and Markides 2007; Schuster and Holtbrügge 2014)	15.74
Profitability/ Financial	(Gino and Staats 2012; McMullen 2011)	49.07
Integrative/Sustainability Development	(Marconatto et al. 2016)	25.93
Social Benefit/Social Performance	(Hall et al. 2012; Halme et al. 2012)	37.04
Environmental Performance	(Hudnut and DeTienne 2010; Rebehy et al. 2017)	12.04

Furthermore, innovation in BoP literature is often regarded as disruptive innovation and frugal innovation (Hall et al. 2012; Howell et al. 2018), both forms of the innovation demand long-term and consumer affordability focus which requires capability development by learning mutually from the BoP markets (Hsu et al. 2014). Similarly, frequently observed risk constructs involve *supply and distribution risk, investment risk, sovereign risk, system risk and demand risk* with frequencies of 34.26%, 31.48%, 29.63%, 28.70%, and 26.85%, respectively. Moreover, the risk management strategies highly recommended by the BoP scholars are *collaboration, product design* and *redesign of chain configuration* with frequencies of 50%, 40.74%, 35.19%, respectively. Lastly, the most frequently mentioned categories for control and

monitoring are corporate citizenship and stakeholder dialogue with 25.93% and 16.67% respectively.

Further, to find the association between the constructs, non-parametric spearman correlation coefficient is calculated.

4.3. Correlation Findings and synthesis of the BoP literature

The correlation findings are further interpreted as a whole and in parts. Figure 3 presents a whole framework derived from Table II. However, the subsequent sections discuss only the parts of Figure 3. Lastly, a model of risk management is presented based on the extensive correlation findings which can be further tested in empirical settings (Fig. 3).

Table 4.2 Correlation findings significant at p < 0.01

Correlation	Correlation Coefficient (0.01)
System Risk ~ Collaboration	0.270**
System Risk ~ Redesign of Chain Configuration	0.259**
System Risk ~ Social Capital	0.280**
Supply/Distribution Risk ~ Redesign of Chain Configuration	0.469**
Supply/Distribution Risk ~ Product Design	0.296**
Supply/Distribution risk ~ Demand Risk	0.370**
Demand risk ~ Product Design	0.252**
Redesign of Chain Configuration ~ Integration	0.346**
Redesign of Chain Configuration ~ Customer Satisfaction	0.311**
Collaboration ~ Social Capital	0.433**
Collaboration ~ Integration	0.386**
Collaboration ~ Local Community Commitment	0.349**
Product Design ~ Customer Satisfaction	0.268**
Product Design ~ Cost	0.356**
Social Capital ~ Local Community Commitment	0.288**
Integration ~ Integrative Sustainability	0.261**
Local Community Commitment ~ Resources	0.333**
Local Community Commitment ~ Customer Satisfaction	0.319**
Local Community Commitment ~ Cost	0.382**
Cost ~ Customer Satisfaction	0.489**
Cost ~ Resources	0.432**
Cost ~ Social Benefits	0.255**
Cost ~ Financial Performance/Profitability	0.278**
Profitability/Financial Performance ~ Social Benefits	0.420**
Resources ~ Sustainable Competitive Advantage	0.276**

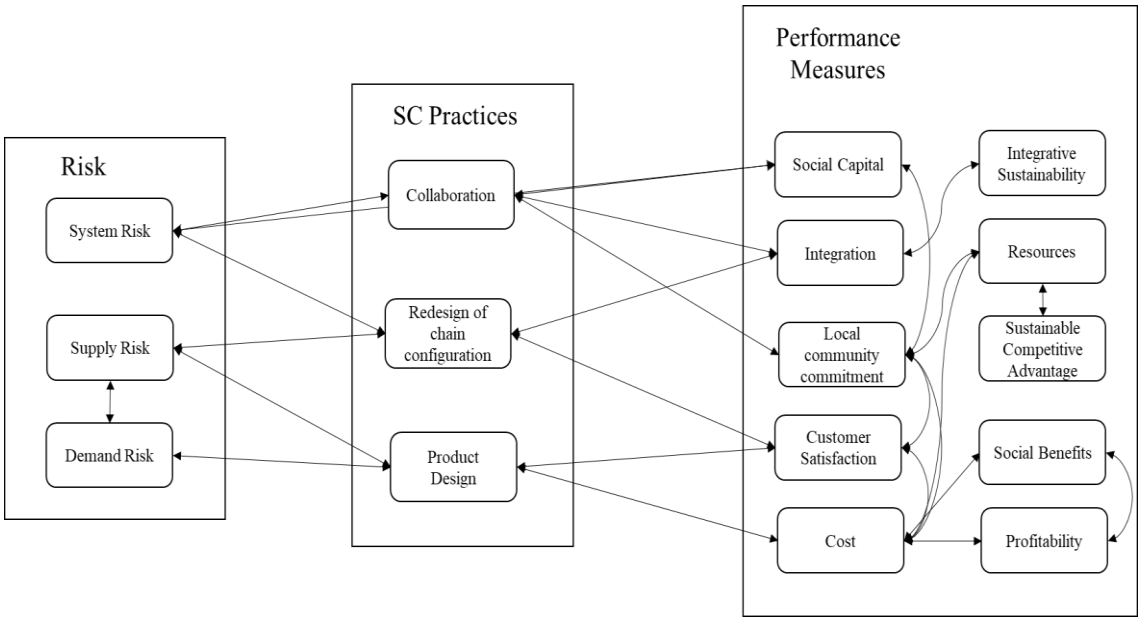

Figure 4.3 Risk framework developed based on BoP literature.

The first analysis (Table II) predicts general association between the risk factors, the management practices, and the performance measures (Fig. 3). The system risk being described as a risk associated with the business ecosystem; therefore, it is viewed here as an overarching risk in BoP supply chains. A significant body of the literature suggests collaboration and redesign of the chain configuration as best strategies to deal with the system risk with a correlation coefficient of 0.270 and 0.259, respectively (e.g., Calton et al. 2013). However, the likelihood of success while pursuing these strategies is highly contingent on the firm's social capital, its ability to integrate as it shows a high correlation between the constructs (Table II). Further, two broad risk categories, i.e., supply risk and demand risk, are also found in BoP literature. Redesigning the chain configuration or infrastructure and product design seem to be a viable method to address these supply chain risks (Zomorrodi et al. 2019). Reficco and Márquez (2012) show that the inclusive networks because of redesigning the infrastructure can function as connecting channels and consequently enhance the flow of information, skills, and resources, making possible the connection of supply and demand.

Findings suggest a correlation between product design, customer satisfaction, cost efficiency and redesign of chain infrastructure (Table II). It entails that the firms which aim to increase customer satisfaction while decreasing the cost are more likely to reduce the demand risk by bringing in new yet cost-efficient product design satisfying the local needs. Therefore, creating distribution channels close to customer vicinity not only reduces distribution risk but also increases customer satisfaction. The cost reduction either through local community engagement or customer expectation for the frugal products increases the social and financial performance,

i.e. creating a win-win scenario (Lim et al. 2013). Subsequently, every part of the risk framework (Fig. 3) will be explained in detail.

System Risk, Collaboration and Redesign of the Chain Configuration

System risk is the lack of compatibility among the supply chain actors, lack of or unreliable information infrastructures, lack of knowledge and awareness about new system, which all together defines the BoP ecosystem, and referred to as 'institutional voids' and 'poverty' within the BoP literature (Seelos and Mair 2007). The incompatibility demands the need to create awareness and knowledge sharing among and within the BoP communities, which if remain unsolvable can make the markets less attractive to the MNCs as well as local producers. Further, the fragile environment of the BoP markets can easily be used for the exploitation of local members of the society (Kistruck et al. 2013). The exploitation leads to a trade-off of social benefit to the sole financial benefit of the big multi-national, transnational, as well as local powerful companies (Arora and Romijn 2012). However, forming collaboration (as an overarching strategical choice) can help in dealing with the system risk (correlation value = 0.270).

A large body of scholars endorses strategies like collaborating with the third party actors, for example, Perez-Aleman and Sandilands (2008) and Varga and Rosca (2019) consider collaboration with NGOs as a preliminary requirement to enter the BoP markets. Because the NGOs tend to have strong links within the community and can serve as a bridge between focal firms and upstream and downstream supply chain actors i.e. dealing with the information infrastructure barriers (Chesbrough et al. 2006). For example, the native suppliers, especially, the small scale often sell their products, lower than market cost, to the available buyers because they lack the resources to reach markets cost-efficiently (London and Anupindi, 2012). NGOs can help in recognizing, training and making them a part of supply chain which in turn empower them and make them compatible to overcome the system risk. Similarly, a correlation between system risk and redesign of supply chain configuration is found at a value of 0.259. The importance of building close associations with the non-traditional stakeholder, i.e. NGOs and often making them a part of supply chain activities are suggested as a viable solution for operating in these markets (Rammal et al. 2014; Scott, 2017). These collaborations create opportunities for MNCs despite the affordability and infrastructural challenges embedded in the environment because they allow the MNCs to increase their absorptive capacity while increasing the native capabilities (Ausrød et al. 2017; Zomorrodi et al. 2019)

Furthermore, international NGOs' collaboration with the government and local NGOs can also be beneficial (Heuer et al. 2020). These collaborations can serve as intermediaries from

the base of the pyramid to international markets as they offer a platform to ensure the compatibility of local produces for international markets. Therefore, the strategical choice of collaboration for entering the BoP markets deals with the system risks.

Supply and Distribution Risk, Redesign of Chain Configuration and Product Design

Supply and distribution risks are associated with the risk of getting the raw material from the upstream supply chain actors and distributing the finished goods to the downstream supply chain actors. The significant sources of risk identified in BoP literature are the quality of service and high cost of transportation of the goods from producers to focal firm and to the retailer. To address this risk, a redesigning of the supply chain and product design are suggested as the best strategy with a correlation of 0.469 and 0.296, respectively.

The redesigning of supply chain infrastructure requires the firms to build widely dispersed locations for their plants and forming network ties (Table II). The buyer firms can benefit from the incorporation of the upstream producers and manufacturers into their supply chain activities which are already decentralized within the BoP communities (Calton et al. 2013). Therefore, the inclusion practices can serve as infrastructure and allow the smooth flow of products and services.

Moreover, the downstream inclusion of supply chain actors (from both formal and informal markets) could be a novel idea of reaching the mass (Vachani and Smith 2008). By benefitting from both formal and informal markets and including them to the distribution of goods and services could help lower the cost of transportation (Ray and Ray 2010). For example, the low-end retailer in a village can be used to sell the products to the BoP community or cheap labour can be utilized for logistic purposes. These local incumbents also possess local knowledge necessary to reengineer the products for local demands (Lim et al. 2013). Therefore, the local inclusion serves both infrastructural as well as knowledge gaps required to design and disseminate the products. This highlights the BoP 2.0, where the firms need to be more inclusive to boost the economic flow by reaching the individuals or small-scale firms and making them a part of supply chain activities.

Demand Risk and Product Design

The significant source of risk identified under the demand risk category is the small consumer base due to affordability issues and the best practice to reduce the impact of this risk is product design (correlation = 0.252). The demand for luxury products is not viable for BoP consumers (Karnani, 2007). To become successful in these markets, the focal firms should be aware of the products they want to offer to these communities and plan to design products, explicitly addressing the demand of BoP consumers. However, the BoP context is inextricably

linked to the prevailing social norms which might reject the otherwise conflicting products. Besides, the economic sustainability and environmental consideration in the product design shows the intricacy required in the manufacturing of these products. The solution to these inevitably complicated product designs has been found in the literature as well. For example, a Haitian supply chain implemented a social product model improving profitability, using renewable fuels for cooking and lighting products while providing one fit for all product for families (Bals and Tate 2018).

Further, a demand forecast for a particular niche leads to creating a single function product. However, this could hinder the product potential to serve the diverse needs of the BoP communities at a low price (Ahrens et al. 2019). Therefore, mass customization through shifting the decoupling point closer to the customer can be beneficial in reducing the demand risk (Suzic and Forza, 2021).

The focal firms with the aim of successful operations in the BoP markets must be well versed in the demand risk which the consumer posits. Poverty is one of the significant characteristics of the BoP markets which implies that the products and services need to be affordable enough to tap the BoP consumer base, which is in line with the idea of BoP 1.0.

Supply Chain Practices and Performance

A correlation between collaboration and local community commitment is observed (i.e., 0.349). The collaborations can also facilitate the manufacturing of cost-efficient products through commitment to the community (Kaplinsky 2011). The partnership with the NGOs provides a platform for both MNCs and local producers which makes it easy for gathering the raw materials or other inputs cost-efficiently, i.e., through building the social capital (correlation = 0.433). Integrating the local community into the SC activities help facilitate the smooth flow of information and material (Karamchandani et al. 2011). It helps in gathering information about the needs and expectations of the local customers, thus, showing firms commitment to the community. The fast and easy access to raw material helps in reducing the overall cost of the final product. Information on the needs and expectations of the customers helps in devising the characteristics of the product being produced (correlation = 0.268). These novel and cost-efficient products with a focus on indigenous needs can help to tap their purchasing power by offering products at affordable rates (Anderson and Markides 2007). Therefore, a correlation between product design and cost efficiency is found (i.e., 0.356). This argument is also in line with the manufacturing of frugal innovative products serving the needs of the poor (Lim et al. 2013). However, even the cost-efficient products and services which are secondary to the basic needs of poor, lack the potential to become successful in these markets

(Karnani, 2007). For that purpose, a business model design with a focus on increasing native capabilities is required (Anderson and Markides 2007; Ausrød et al. 2017). Local community engagement either through the incorporation of local entrepreneurs or the labour, from these labour intensive markets, into the economic activities not only boost the native capabilities but also keep an active economic flow (Chesbrough et al. 2006).

Furthermore, a correlation between cost and social and financial performance is found as 0.255 and 0.278, respectively. The firms and indigenous people simultaneously create financial and social sustainability by following cost efficiency. On the one hand, the focal firm can gain economic benefits by offering cost-efficient products to tap the needs of a large consumer base (Calton et al. 2013). On the other hand, the inclusion of these, otherwise unrecognized, individuals or small and medium enterprises with the aim of saving overall cost creates social sustainability (Golicic et al. 2020; Halme et al. 2012).

Interlink between Performance Measures

A correlation between integration and integrative sustainability has been found (i.e., 0.261). The MNEs opting for the BoP ventures increase their corporate social responsibility (CSR) as well as BoP economic growth by increasingly adopting cross-boundary team-working, appoint top international teams, and CEOs from emerging nations (Bardy et al. 2012). Companies that realise the importance of intercultural differences attached to the risk of foreign direct investment (FDI) in developing nations can benefit from this sustainable global economic integration (Bardy et al. 2012). Moreover, the social capital for extending the BoP business concept serves as a pivotal step in comprehending the role of the local community in such ventures (correlation = 0.288). The BoP scholars have realised the societal benefits emanated from the local community relationships (Akula, 2008; Scott, 2017). Firms through enabling capability development in BoP communities by creating and sustaining intra-group bonding and inter-group bridging social capital will likely increase knowledge transfer to BoP communities, leading to capability building among these communities (Ansari et al. 2012; Hill and Mudambi, 2010). Despite the difference between resource-rich and resource-poor business ecosystems, these capability development frameworks can aid in empowering the impoverished (correlation between local community commitment and resources = 0.333). BoP communities, specifically, can gain higher benefits from the capability enhancement initiatives because of their extensive human capital. Well trained and specialized human capital then act as resources for big MNCs and local producers alike and serve to attain sustainable competitive advantage (Hart and Dowell 2011) (correlation = 0.276).

In sum, the three identified risk categories and their respective management strategies are closely associated with the evolution of the BoP concept. The supply and distribution risk are linked to the inclusive business activities for poverty alleviation, i.e. dealing with the BoP 2.0. Similarly, the demand risk is related to the consumer focus for poverty alleviation, i.e., BoP 1.0. Some overlaps in both (former and latter) are also observed. The system risk, however, is an overarching risk factor covering both aspects from institutional voids and poverty alleviation. Related strategies to address these risks and the impact on the performance outcome proffers valuable grounds for the discussion of the topic under study.

Furthermore, the use of performance measures in the BoP literature is divided as process and outcome. Based on these extensive correlation findings from the BoP literature, Figure 4 is devised as below:

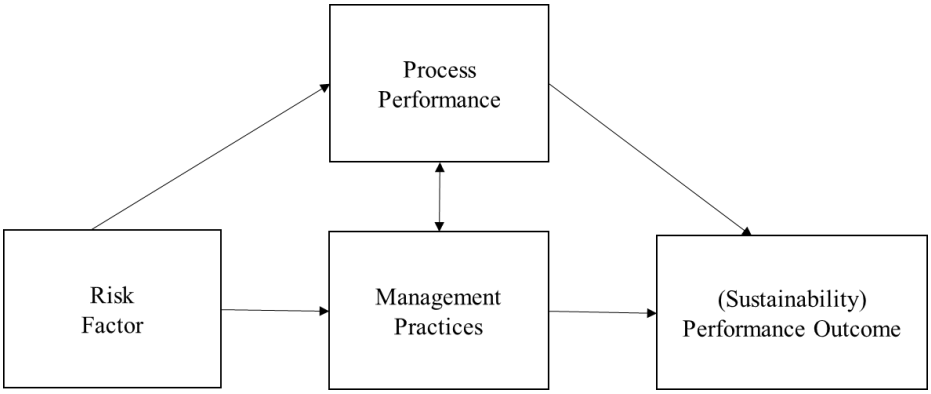

Figure 4.4 Model of Risk Management

To achieve high sustainability targets, the management of risk is highly contingent on the mitigation practices as well as the process performance measures. Therefore, Figure 4 shows a model which can be further tested in different empirical settings.

5. Discussion

BoP literature offers prominent papers highlighting risks, challenges, constraints, and their effect on the performance of the supply chain (London et al. 2010). However, less consideration is given to the management practices to reduce their impact based on performance measurement. The current paper is, therefore, advancement into the knowledge regarding management of SC risk through related performance measures to reach its targets. Furthermore, the broader SCRM literature often neglected the role of sustainability performance efforts (i.e., performance measurement systems) in the SCRM process, which is added in this paper and

considered a contribution to the broader domain. Therefore, the paper contributes to both BoP and SCRM literature, discussed in the subsequent text.

It is worth noting that the risk management practices frequently mentioned in the BoP literature mainly comprised the strategical level 'preventive' practices, which shows that the BoP literature considers the environment as an uncertain ecosystem for businesses and demands long-term solutions for the management of the risks therein. Nevertheless, the performance measures proffered are more tactical, showing that incorporating these measures could help neutralise the supply chain uncertainties engrained in the environment.

Furthermore, the value creation process, in the BoP markets, is profoundly inhibited by the local productivity constraints (London et al. 2010). These constraints are linked to the upstream supply chain risks identified as supply, investment, and manufacturing risk. Furthermore, the supply risk due to vast geographical dispersion with poor infrastructure makes the acquisition of the raw material costly, which disables the local value creation (London et al. 2010). This often demands the incorporation of already dispersed local networks in the society, thereby redesigning the SC. Therefore, the management practices found to address the risk further help in achieving firm's performance goals through continuous monitoring and measuring cost.

Further, the transactional constraints in BoP markets, which can hinder the value capture process, are also discussed (Kistruck et al. 2013). These constraints include market access, market power, and market security (London et al. 2010) and are linked to the downstream supply chain risks. The market access deals with the distribution risk identified in this paper; however, the market power, which we highlighted as a demand risk realise largely on affordability related challenges. Furthermore, the demand forecast for a particular niche helps create a single function product that could hinder the product potential to serve the diverse needs of the BoP communities at a low price (Ahrens et al. 2019). Therefore, it is suggested that mass customization through shifting the decoupling point closer to the customer can be beneficial in reducing the demand risk (Suzic and Forza, 2021).

Whereas the market security has not been addressed sufficiently in the literature so far. Supplier development and the use of social certification has been mentioned in BoP literature for bridging the institutional voids (Brix-Asla and Seuring, 2020). However, the standard and certificates, which are the standards to analyse the sustainability of suppliers, cannot adequately serve as security for the products offered based on them. For example, the certificates, where the power and opportunistic behaviours from the supplier as well as the non-governmental bodies can easily forge them, might not assure the sustainability of the products. Therefore, the control of these risk factors through a thorough process of devising and continuously

monitoring should be important for the management of these risks. Still, the BoP literature has not sufficiently focused on the monitoring tools neither on the supplier risk, which further leaves a room for prospective studies to explore the matter in detail.

Furthermore, the BoP literature suggests that the risks, if managed appropriately, bring in social benefits on the one hand and tap the potential customers on the other (London et al. 2010). The focal firms will help the locals to utilize and enhance their skills by getting benefits from the learning opportunities provided by these large institutions. The information asymmetry and knowledge gap can be filled in this way and can further enhance the living standards of the indigenous. Therefore, the management of risk contributes to the sustainability performance of the supply chain. However, the otherwise untapped markets can be the potential actors of the supply chain, but there is also a problem of opportunistic behaviours from either the suppliers or the distributors (Gold et al. 2013). Therefore, the BoP ecosystem demands collaborator that can initiate or regulate a fruitful relationship between the parties (Munir et al. 2020).

Further, collaboration as an overarching risk management practice has several limitations. On the one hand, strong government bodies with ethical power utilization through coercive pressure can help in creating shared value (Marconatto et al. 2016; Jajja et al. 2019). On the other hand, researchers caution also surges in the literature regarding weak regulatory authorities in these markets. Karnani (2007) mentions that people living in poverty are the result of government failure. Lack of reforms and power difference (Arora and Romijn 2012) from the government can turn the otherwise fruitful collaboration into a massive failure. Similarly, authoritative government bodies can also influence the collaboration between NGOs and the firms and these triggers also play a significant role in the firm's choice of building social alliances with the non-traditional partners (Murphy et al. 2012). Making the process more transparent by building collaboration through integrating locals by building strong social capital and regularly measuring its impact would help to overcome these challenges. However, the BoP literature points out these performance measures but lacks an appropriate performance measurement tool to monitor the progress. Nevertheless, a collaboration themed score card would help in this regard (Kaplan et al. 2010).

For general SCRM literature, the study at hand proffers several contributions. Previously, supply chain risk management literature highlights performance role in the risk management but somehow lacks in-depth exploration of it (Tummala and Schoenherr, 2011). By exploring it through BoP literature, it is found that the performance measures have been linked to various risk management strategies and incorporating them into performance measurement systems

would not only facilitate the implementation and monitoring of risk management practices but also help achieving the sustainable long-term performance targets (Arzu and Erman 2010; Beske-Janssen et al. 2015; Maestrini et al. 2017; Seuring and Müller, 2008).

The findings emphasize the role of social capital and integration of locals to ensure the management of related risks and thereby achieving performance goals. For example, a local producer in the BoP environment with extensive social capital can actually utilize the connections to save extra cost which a producer without social network might incur while redesigning the supply chain infrastructure to minimize supply and distribution risk (Karamchandani et al. 2011). Similarly, integrating the locals having social connections with the strong and influential government bodies can facilitate the collaboration which otherwise could succumb to weak regulatory authorities in these markets. This is also an extension to the BoP literature where the performance aspect is explored but not explained through strategy and performance measurement perspective, e.g., Rehman et al. (2020).

5.1. Practical Implications

The risk management practices presented in this study can help managers devise a plan for managing associated risks. Further, the constructs suggested in this study can be used for the measurement of performance to timely control the risk, as it is often underlined that ‘what is not measured is not managed’ (Manuj and Mentzer 2008, p 216). Therefore, the firm's performance measurement plays a crucial role in the risk management process, and the managers should know and incorporate the performance measurement system to manage risks and thereby achieving high performance goals (Grosvold et al. 2014).

5.2. Future Directions and Limitations

The research holds several limitations, as well. The use of specific keywords might have resulted in the selection of most, not all, of the BoP papers, i.e., targeting a sample of risk papers from the entire BoP literature. Further, the sample of papers is limited to December 2019, which can be updated in future studies. The study at hand conceptualizes the role of performance measurement systems in the risk management process but could not find sufficient literature, which leaves a gap for future studies to address. It nudges future researchers to find how the highlighted performance measures and the related strategies can help managers of the BoP countries by conducting empirical research.

Besides, the BoP literature mostly lacks evidence for the management of the disruption risk, originating from natural disasters, wars, etc., so far (Table II). The environmental risk could also be seen from the perspective of BoP population, for example, the people, lacking knowledge and awareness, may not think of cutting trees as environmental degradation but a

mere source of income. It also raises a question whether addressing the social sustainability issue can contribute to environmental sustainability as well? Or a trickle-down effect from an enforcement body could sufficiently help in dealing with these issues.

Moreover, the informal transactional means have long created trust among the local consumers regarding their products and services. For example, a loan from a close relative even at markup higher than the market would deem as a reliable source than from a Bank (Akula, 2008). Therefore, the lack of awareness and trust among the BoP members regarding the new products or services can also contribute to demand risk. However, the informal context also requires more attention and how innovation and social capital can help in dealing with the ingrained risk could proffer valuable insights.

6. Conclusion

In seeking to address the contemporary challenges in supply chain management for the sake of attaining sustainability, BoP research remains at an early stage and in need of stronger theoretical foundations. Further, the need to evaluate the compatibility of current SCRM and SCPM knowledge with the exclusive business environment of informal markets in emerging economies derives this research. Yet, the solutions offered by the literature remain largely on the macro-management level. In the relevant literature, certain strategies developed in the context of supply chain operations in the developed world have been found suitable in the context of the developing world. The respective supply chain strategies address the questions about how risk management has been dealt within the BoP literature (Fig. 4). The findings showed a broad strategical aspect of SC risk management practices and proffered the operational level performance measures which along with these practices can manage the related risks. The present findings also highlight how central aspects of supply chain and risk management like manufacturing and control and monitoring tools have been under researched in the BoP literature. The framework including process performance dimensions is the contribution to the broader SCRM stream where this performance aspect is only mentioned superficially.

5. Comparing regions globally: Impacts of COVID-19 on supply chains – A Delphi study

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Abstract

Purpose – The COVID-19 pandemic has challenged supply chains (SCs) around the globe unprecedentedly. This study aims to gain insights on the impacts of the pandemic on SCs and their management under consideration of different regional contexts on a global scale.

Design/ methodology/ approach – A Delphi study collects the expertise of global SC academics on the SC vulnerabilities and the measures for responding to disruptions, improving resilience, and restoring operations. Data from three polls are systematically analyzed by content, frequency, and cluster analysis.

Findings – The study identifies and ranks ten major issues related to SC vulnerabilities and management strategies for specific SC processes and geographical regions. Detected differences among the considered geographical regions point towards particular challenges and call for specific measures to integrate regional contingencies into supply chain management. In a regional comparison, China and Iran as well as Africa clearly stand out, but also Europe/North America, India/Pakistan, and Brazil show geographical particularities.

Research limitations/implications – The responses are collected against the COVID-19 pandemic, while the findings show differences among the regions thereby arguing for taking regional contingencies into account in managing supply chains.

Practical implications – SC resilience is a core aim, which was emphazised by the COVID-19 pandemic. The findings provide insights and challenges that managers would have to meet in the different regions covered.

Originality – This paper contributes to existing knowledge on SC risks and SC resilience in context to extreme situations. Given that events, such as the COVID-19 pandemic, will become more frequent in the future due to climate change and geopolitical tensions, insights into how to manage SCs under extreme conditions and into regional differences are crucial.

Keywords – Supply chain management, supply risk, resilience, global operations management, COVID-19, Delphi study.

Paper type – Research paper

1. Introduction

The COVID-19 pandemic has severely impacted local and global economies and disrupted supply chains (SCs) for most product categories (Sodhi and Tang, 2021; Ivanov, 2020a). Many enterprises were unprepared regarding the impact of the pandemic which was further complicated by simultaneous disruptions of demand and supply (Ivanov, 2020a). Lockdowns or travel restrictions disrupted SCs upstream, while panic buying of particular products triggered demand distortions downstream the SCs (Nikolopoulos *et al.* 2021).

Supply chain management (SCM) researchers have emphasized the importance of risk and resilience and have called for more empirical and event-based research in those areas. A majority of studies cover the preparation and mitigation phases with activities prior to a disruption, while literature on post-disruption activities within the response and recovery phases is scarce (Natarajarathinam *et al.* 2009; Ellis *et al.* 2011; Xu *et al.* 2020a). More studies elaborate on the assessment and mitigation of SC risks than on SC resilience and disruption management, and SCM literature on pandemics and epidemics is widely lacking (Pournader *et al.* 2020; Sauer *et al.* 2022), so even wide-range overview papers do not mention this as a topic (e.g. (Xu *et al.* 2020b). Hence, further empirical research is needed to analyze how companies deal with the challenges of COVID-19 and which mechanisms may help mitigating unwanted impacts (Ivanov and Dolgui, 2020, van Hoek, 2020) – specifically, how different regions globally might have diverging insights and demand differentiated measures.

Given the heterogenous distribution and organization of SC processes across different regions of the world, it can be assumed that the pandemic has exposed heterogeneous vulnerabilities of SCs and thus requires a diverse set of responses. For this reason, and given the unprecedented scale of the impact, this event has provided a valuable opportunity to explore the impact of disruptions in different regional contexts and how they build resilience for the future. Most empirical studies focus on one particular region and, hence, cross-regional analyses are scant.

The study delves into this gap and elaborates on the following two research questions (RQ):

- RQ1: What vulnerabilities do SCM experts see SCs being confronted with during the COVID-19 pandemic, and what measures do they suggest to respond, build resilience, and restore operations of firms and SCs?
- RQ2: Which regional similarities and differences are detected with regard to factors of vulnerabilities, response measures, SC resilience, and restoring operations?

A Delphi study with open data collection and structured feedback is conducted to answer the two RQs. Given the cross-organizational and complex nature of the COVID-19 pandemic, this approach is suitable. The respondents who judged upon the impacts of the COVID-19 pandemic on global SCs in different regional contexts are experts in the SC field in which opinions could, at the same time, support a broad research approach and allow an in-depth understanding (Seuring and Müller, 2008). To investigate if the expected heterogeneity is evident, functional particularities and geographical contexts are systematically contrasted to identify similarities and differences. With the selected developed and emerging regions (Africa, Brazil, China, Europe and North America, India and Pakistan, and Iran), the study covers a wide range of economic and structural differences as well as varying pandemic trajectories.

The remainder of this paper is structured as follows. The review presented in Section 2 provides an overview of related literature while the research design and methods are explained in Section 3. Section 4 presents the findings of the study which are discussed in Section 5. The paper ends with concluding remarks on the contributions and limitations of the study summarized in Section 6. The appendix contains supplementary data of the study.

2. Literature review

2.1. SC risk management and SC resilience

The number of disruptive events with negative impacts on competitiveness of firms and SCs has considerably increased over time (Colicchia and Strozzi, 2012; Sheffi and Rice, 2005). Hence, SC risk management, defined as “the management of SC risks through coordination or collaboration among the SC partners so as to ensure profitability and continuity” (Tang, 2006, p. 453), has nowadays become a prominent area of SCM research (Kamalahmadi and Parast, 2016). However, many practitioners still underestimate the relevance of SC risk management or leave SC risks unaddressed and, thus, fail to prevent negative impacts of SC disruptions (Tang, 2006; Macdonald and Corsi, 2013). Traditional risk management systems often remain ineffective because they identify only predictable risks based on statistical information but omit unpredictable risks that emanate from unexpected events (Fiksel *et al.*, (2015).

Developing resilient SCs is one possible approach to overcome the problem that traditional SC risk management systems cannot react adequately to sudden disruptions (Kamalahmadi and Parast, 2016). Resilience is a multidimensional concept with the ability to return to a state of stability (Kamalahmadi and Parast, 2016), and, thus, resilience is not about returning to business as usual

but about adapting to new situations (Iyengar *et al.* 2021). SC risk management and SC resilience are complementary concepts because successful SC risk management reduces the disruption likelihood and, therefore, improves SC resilience (Sheffi and Rice, 2005; Fiksel *et al.* 2015).

SC resilience offers a competitive advantage for companies, as they learn how to deal with disruptions more effectively than their competitors and how to even generate benefits from disruptions (Sheffi and Rice 2005; Fiksel et al. 2015). Capabilities include collaboration, visibility, redundancy, and flexibility (Sheffi and Rice 2005). SC resilience cannot be developed by a single company, but the entire network needs to recognize risks and prepare collectively since SCs span globally and, hence, risks arise between firms (Colicchia and Strozzi, 2012).

In this study, SC resilience is defined as "the adaptive capability of the SC to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function" (Ponomarov and Holcomb, 2009, p. 13).

2.2. SC risks and SC resilience in the context of the COVID-19 pandemic

SC risks include "any risks for the information, material, and product flows from original supplier to the delivery of the final product for the end user" (Jüttner *et al.*, 2003, p. 200) that lead to a "variation in the distribution of possible SC outcomes, their likelihoods, and their subjective values" (March and Shapira, 1987, p. 1404). SC risks can be divided into operational and disruption risks (Tang, 2006; Ivanov, 2020a). The former are related to interruptions in day-to-day operations, e.g., prolonged lead times or demand fluctuations, and the latter refer to so-called low-frequency-high-impact events such as man-made threats or natural catastrophes like a pandemic. The pandemic spreads through the population and creates high uncertainties due to disruptions in supply and demand and the logistics infrastructure. Epidemic outbreaks start small but spread quickly and have an impact across all all regions that can however differ in its magnitude across time and different parts of the SC (Sauer *et al.* 2022).

Unpredictable events confront enterprises with major challenges that can impact their performance (Tang, 2006). The financial crises in 2008/2009, natural disasters like the Japanese earthquake and tsunami in 2011, or health epidemics such as the COVID-19 pandemic are unpredictable events that occured in recent years. Given that future risks like those triggered by climate change or geopolitical tensions may continue to arise unexpectedly, companies should

consider how they can prepare for these risks and manage their SCs under such conditions (Sodhi and Tang, 2021).

SC risks resulting from epidemics or pandemics represent a new research topic (Ivanov, 2020a; Natarajarathinam *et al.* 2009). The impacts on SCs for commercial products are seldom considered, and strategies for rapid response and recovery are scant (Paul and Chowdhury, 2021).

Sodhi and Tang (2021) examine the challenges and response actions due to COVID-19 and the way in which the impact on SCs differs from other severe disruptions. They found that the consequences exceed a limited number of SCs and a defined period of time, necessitating a new type of SC management (SCM) to deal with such extreme situations. Ivanov (2021) concludes that many SCs were overwhelmed due to the severity of the impacts, resulting in many bottlenecks, chaotic actions, and high vulnerability to the ripple effect. Chowdhury *et al.* (2021) provide an overview of the impacts of the pandemic mentioned in the current literature. Most frequently cited impacts include simultaneous demand increases and shortages for essential products, disruption of supplies and production, lack of international transportation, delays in delivery and production, and health issues (Ivanov and Dolgui, 2020; van Hoek, 2020; Paul and Chowdhury, 2021). Many researchers expect that the consequences are long-lasting in nature and address an increased need for SC resilience strategies (Ivanov, 2020a).

A comprehensive and holistic response plan that includes a variety of diverse measures is necessary to adequately respond to the impact of the pandemic (Ivanov and Dolgui, 2020). A variety of responses is more beneficial than, e.g., a mere collection of alternative suppliers (Kahiluoto *et al.*, (2020). Measures outlined to respond to the impacts and to build resilient SCs include increasing production capacity (Paul and Chowdhury, 2021), redesigning logistics and diversifying production sites (Rowan and Laffey, 2020), mapping the SC network for improved SC visibility (Ivanov and Dolgui, 2021), or expanding IT capabilities (Choi, 2020). An SCM approach that responds to such an extreme situation must simultaneously consider demand and supply security, channel stability, labor availability, SC visibility, geopolitical stability, SC resilience, and SC financial flows (Sodhi and Tang, 2021).

Research on SC risk and SC resilience in context to the COVID-19 pandemic has emerged and underlined the importanc of spatial differences (Sauer *et al.* 2022) . When considering the regional context, it becomes apparent that in most cases, either a single state (e.g. Choi, 2020), Hong Kong; Sharma *et al.* (2020), USA) or a few countries (e.g. Handfield *et al.* (2020), United Kingdom and USA; Veselovská (2020), Central Europe) are in focus, or no specific geographical regions are

considered (e.g. Jabbour *et al.*, 2020; Paul and Chowdhury, 2021; van Hoek, 2020)). Ivanov and Das (2020) analyze the impact of COVID-19 on global SCs based on data from Brazil, China, Germany, and USA and provide mitigation strategies, and Nikolopoulos *et al.* (2021) predict SC disruptions based on data from Germany, India, United Kingdom, and USA. However, neither of these two studies compares the considered countries. To our best knowledge, no study provides a structured global comparison of SC risks and resilience practices in context to the COVID-19 pandemic. Therefore, this study represents an important extension of our knowledge on the effect of a pandemic on SCs, also justifiying that a theory elaboration approach (Fisher and Aguinis, 2017) is taken.

3. Research methodology

Delphi is the method of choice because it aims to encompass and specify a complex topic and to reach consensus in several rounds within an expert panel that can also comprise sub-panels to enable a contrasting of sub-panel differences (Linstone and Turoff, 1975). For each round, individual questionnaires including structured feedback are used, thus increasing data richness and construct validity (Okoli and Pawlowski, 2004).

Delphi studies are particularly useful for complex and interdisciplinary areas where little evidence-based literature is available (Akkermans *et al.* 2003) and where research "can benefit from subjective judgements on a collective basis" (Linstone and Turoff, 1975, p. 4). Such studies support a broad research approach and allow an in-depth understanding (Seuring and Müller, 2008), e.g., of the current pandemic situation. Due to the novelty of the COVID-19 pandemic, expert opinions seem to be an adequate source of information.

3.1. Selected regions

The study aims to provide a global and region-specific overview of the pandemic's impact and resilience-building measures. The geographical regions selected from five continents cover a wide range of economic and structural variety as well as several pandemic trajectories.

Regional clusters are formed in order to obtain sufficiently high response rates for each cluster. Europe and North America are grouped due to their similarity in the levels of economic development, technology, and education and also in their political business environment. African countries are combined to one cluster because the African countries in our sample are confronted with similar political, socio-cultural, and economic challenges that hamper the implementation of COVID-19 measures (Waya et al. 2021), and they all show comparable standards of living and

(manufacturing and logistics) infrastructure. Treating Brazil (as the only South American country) and Iran (with its very specific, nearly globally unique economic situation with an embargo and strong economic sanctions) as single countries is straightforward. Due to their economic size, China as well as India could remain ungrouped (worldwide #2 and #6 in terms of GDP, see https://oec.world/en/profile/country/chn and https://oec.world/en/profile/country/ind; both accessed on March 31, 2022), but due to the low number of respondents, Pakistan needs to be grouped either with China or with India. We decided to group Pakistan with India for reasons of geographical proximity, macro-economic similarity, and shared culture and history: Pakistan is a neighboring state of India and China, but its border to India is much longer than the one to China. Moreover, Pakistan and India both have coastlines along the Arabian Sea, which China does not have. Pakistan's GDP per capita (1,188.86 US$) is closer to India's (1,927.70 US$) than to China's (10,434.78 US$) (figures from 2020, see https://oec.world/en/profile/country/pak; accessed on March 31, 2022).

In total, six different geographical regions were assessed and compared, which provides insights on a wide range of economic contexts and gives an almost global perspective. The resulting developed and emerging regions and economies (United Nations, 2019) are listed in Table 5.1.

Table 5.1: Reasons for selected regions

Region	**Specific characteristics**
Africa	- Multiple political, social-cultural, and economic challenges hampering implementation of COVID-19 measures - Low living standards and low manufacturing and logistics infrastructure resulting in higher vulnerability to the pandemic
Brazil	- Largest economy in South America, important manufacturing country, especially for North America - Marked by income inequality, corruption, and low governmental awareness for the COVID-19 pandemic (Phillips, 2020) - Highest number of confirmed cases and second-highest number of deaths globally in April 2021 (World Health Organization (WHO), 2021b)
China	- Globally one of the most important trade goods producers (Yang *et al.* 2020) - First outbreak in China - Low infection numbers after first wave in April 2020 (World Health Organization (WHO), 2020)
Europe & North America	- Industrialized nations with strong global economic activities - Some countries are among the most affected by the pandemic worldwide (World Health Organization (WHO), 2021a)
India & Pakistan	- Increasingly attractive production locations that could become an offshoring alternative to China (Govindarajan and Bagla, 2015). - Large populations - Heavily affected by the pandemic
Iran	- Under multiple sanctions since 1980 (Danaei *et al.* 2019)

	- Excluded from global financial market, reduced export of oil, harsh business conditions, restricted access to medical equipment (Karimi and Haghpanah, 2015)

3.2. Selection of experts

Delphi studies require a qualified panel of experts (Seuring and Müller, 2008). Initial sampling followed by snowballing was the method of choice to collect a suitable group of experts. Adopting methodological guidelines on participant selection (e.g., Okoli and Pawlowski, 2004), experts from the professional network of this research team were originally contacted, who then recommended additional experts (see Table 5.2). All first-round participants were selected on the basis of their academic output, their membership in scientific networks such as EurOMA, and their experience in SCM.

Table 5.2: Participants of the Delphi study

Region	**Round 1**	**Round 2**	**Round 3**
Africa	15	17	10
Brazil	9	20	21
China	14	16	16
Europe & North America	33	37	29
India & Pakistan	5	18	23
Iran	19	16	18
Total responses	**95**	**124**	**117**
Rate	**12.4%**	**15.9%**	**14.9%**

The sampling process resulted in an adequate mix of academic and industry expertise of the respondents. The average job experience of the experts is 14 years in academia and 7 years in business practice, and about one-fourth of the respondents were actively working in industry (see Appendix 2). Such a combination of academic expertise and practical experience is ideal for the context of this Delphi study because it ensures that the participants are close enough to operational practice, and it allows the involvement of reseachers who are more reflective and take an aggregated perspective.

As explained in section 3.1, the experts were grouped in regional-specific sub-panels. Typically, ten to 18 persons per group should be interviewed to achieve robust construct validity (Okoli and Pawlowski, 2004) and to avoid bias (Akkermans *et al.* 2003). This number is achieved for the single regions allowing that the regions can be compared.

Since only some of the first-round respondents replied in the second round, the expert panel was expanded in round two. Although participant drop-ins can sometimes be seen critical, they can be found in previous Delphi studies as well (e.g., Sauer and Seuring, 2019). Because we guaranteed anonymity to the experts in the sample, such drop-ins can hardly be avoided. Moreover, the expert selection needs to be aligned with the study goals that can be quite different across different Delphi studies (Okoli and Pawlowski, 2004). This study aims to generate items in the first round and investigate their regional importance and related differences in the second and third round. Following the guidance on alignment of aims and expert panels in literature (e.g., Goodman, 1987; Akkermans et al. 2003), there needs to be a good consistency in participants between rounds two and three that aim to refine the regional importance. Checking for this, we find that across all seven regions only a total of 25 experts (21% of total round three participants) are drop-ins in the last round. The share of experts working in industry increases in the later rounds (see appendices 1 and 2), which again aligns with the aim of these rounds to represent items with high relevance for industrial practice.

Two measures were taken to further ensure a consistent quality of answers. First, the responses of each expert were checked for completeness, the compliance to specifics of the questions such as "select at most three important items," and a logically required minimal time taken to seriously answer all questions. Data sets violating the conditions were taken out from further analysis. Second, consistency checks were applied to verify that the answers of drop-ins do not systematically lie outside the range of answers given by those participants from the same region that participated in the previous rounds. While the first check led to the exclusion of several answers, the second check evidenced the consistency of all remaining reponses. Overall, we are confident that the sample stability is sufficiently high and that responses are consistent. Hence, the overall findings of the study are not seriously affected by drop-ins or drop-outs and, thus, the obtained results remain valid.

3.3. Study design

The study follows the three-round structure proposed by Okoli and Pawlowski (2004). Each round involved the collection of data through a questionnaire, followed by data analysis.

The questionnaires were created and administered in English for all regions using the online tool "SoSci Survey" (Leiner, 2021). To ensure high-quality results and to guarantee a high degree of transparency and replicability, the research team followed accepted guidelines, rigorously

designed the study, documented processes, and pre-tested each questionnaire (Okoli and Pawlowski, 2004). E-mail invitations were sent to the participants with an access link of the questionnaire without any prior contact. Each invitation contained information about the aim and structure of the study, the expectations towards the experts, and the duration of the participation, as recommended in the Delphi literature. Additionally, two reminders were sent in each round in two-week intervals.

All region samples addressed the same four questions that were phrased as open and general as possible to cover all facets of the COVID-19 pandemic:

- Q1: What vulnerabilities are firms and their SCs currently facing?
- Q2: How and by which measures are companies responding to SC disruptions?
- Q3: How are companies proactively building resilience into their SCs to mitigate future risks?
- Q4: How do companies restore their operations and SCs to move back to their business activities?

The research questions build on existing comprehensions of supply chain risk and resilience, thereby the Delphi study design permits theory elaboration logic (Fisher and Aguinis, 2017). The empirical data thereby enables a revised comprehension of existing knowlegde.

In the first round, the participants were asked to answer the questions by explaining the three most important issues per question. To condense the 95 expert contributions into a scheme that allows comparison between regions, an inductive content analysis was performed. Data was analyzed regarding similarities (Neuendorf, 2017), thereby gradually reduced, condensed (Eisenhardt, 1989), and summarized (Mayring, 2015). The answers of each region were analyzed by two researchers individually. Afterwards, the results were intensively discussed within the entire research team in a “discursive alignment of interpretation” (Sauer and Seuring, 2019, p. 35). These analysis steps increased the validity and inter-coder reliability of the condensation and selected constructs. As a result of the content analysis, ten cross-regional constructs were identified.

The constructs represented the rows of a matrix which served as a basis for the second-round survey. The matrix columns were formed by the three core business processes (*Source*, *Make*, *Deliver*) of the SC Operations Reference (SCOR) model to ensure localization within the SCs (APICS, 2017): *Source* processes are related to procurement and receipt of raw materials, components, and services, while *Make* processes represent the transformation of raw materials and

components to subassemblies and finished products, and *Deliver* processes are associated with the distribution of products and services to fulfill customer orders. The SCOR model maps the intra- and inter-organizational SC processes and, thus, suitably reflects the SC impacts of and responses to the COVID-19 pandemic.

The aim of the second-round survey was to validate the constructs found in the first round and to identify regional differences. The respondents were asked to select (without ranking) at most three constructs per SCOR process and question (Q1 - Q4) that have highest relevance for their region, i.e., at most nine boxes had to be ticked per question. We provided definitions of each construct to avoid ambiguity. The second-round data was analyzed by frequency analysis and hierarchical cluster analysis based on the Ward (1963) algorithm. The cluster analysis groups regions with high similarity of results to one cluster and forms individual clusters that differ from each other as much as possible.

The third-round questionnaire was based on the second-round questionnaire which was complemented by the results of the frequency analysis from the second round, i.e., the respondents were informed about the second-round frequency distribution of the constructs in each process for each question within their region. The experts were asked to reconsider the answers from the previous round against the regional group feedback and to re-evaluate the constructs for each process and question (Goodman, 1987). This typical process of a Delphi study ensures a high degree of internal validity. Frequency and cluster analysis were conducted again to obtain the results from the third round.

Due to the binary nature of the results, the homogeneity of the second and third-round results for all items in all six regions has been checked by a Kruskal-Wallis test which showed a high degree of internal validity of the responses because more than 80% of all constructs from the second round were confirmed in the third one. Considering the dynamic of the pandemic, we deem this to be sufficiently homogeneous to finalize the Delphi rounds and use the third-round results for further analysis.

4. Findings

4.1. Content analysis

The content analysis of the first-round survey resulted in the ten constructs (alphabetically): (1) digitalization, (2) finance, (3) government, (4) human resource and hygiene management (HRM), (5) logistics, (6) risk management culture, knowledge, and system, (7) SC volatility/agility, (8) SC

disruption(s), (9) SC disturbance(s), and (10) supply network. The constructs SC disruption and SC disturbance only appeared in the first question and risk management culture, knowledge, and system only in the last three questions. The underlying definitions of the constructs and an overview of the results can be found in the appendix. In the following, the answers to the four open questions given by the SCM experts are described for each construct while taking into account regional differences and similarities.

Supply network

Vulnerabilities derive from lack of cooperation and coordination caused by transparency deficits between SC partners. The experts reported vulnerabilities caused by dependencies on a few suppliers. Especially in Africa and Europe/North America, the high dependency on China leads to difficulties. SCM in China is challenging due to different pandemic situations in the partner countries. Companies in all regions respond to these vulnerabilities by increasing cooperation between SC partners. They create open channels of communication and information to generate visibility and transparency. Enterprises diversify their SCs by seeking alternative suppliers and implement measures such as nearshoring, reshoring, and local sourcing. China strives to substitute closed factories and generate new local customers. Especially in Europe/North America, a clear focus is put on measures that strengthen collaboration and promote communication. China makes efforts to downsize its international business. To restore operations, firms try to redesign the supply network by establishing temporary or permanent substitutes for material sources, diversifying suppliers, creating new business relationships, especially with online suppliers, and shortening the SCs.

SC volatility/ agility

Challenges that can be attributed to SC volatility comprise changing demand pattern, shifts in customer requirements, and the inability to quickly adjust production capacities in lean manufacturing. Firms respond with increased agility either by shifting manufacturing orders to other countries or by canceling them and adjusting production and delivery schedules. In Europe/North America, reductions in resources and capacity as well as shifts to other materials and products add further complexity. Africa, China, India/Pakistan, and Iran switch production to manufacture hygiene products. Further measures to increase SC resilience include simplifying and reducing products or building up inventories. Brazil, India/Pakistan, and Iran focus on the development of in-house capabilities to reduce dependence on suppliers. A slow restart of production in line with demand is needed to restore operations in India/Pakistan and Iran.

Workforce/ HRM

Occupational health, safety, and hygiene regulations pose vulnerabilities. Especially in Europe/North America, this leads to reduced working hours, teleworking, and staff absence due to illness or closed borders. Two kinds of responses to these challenges are observed in China and Europe/North America: Some companies reduce working hours, increase their temporary workforce, and lay off employees, while other firms incentivize employee recruitment or transfer their staff to other companies. All regions, especially Brazil, take measures such as hygiene regulations and safety measures, training, and teleworking to ensure the health and safety of workers and employees. Resilience measures include flexible working hours, safety protocols, and employee training. Moreover, the innovative capacity and creativity of employees is promoted.

Risk management culture, knowledge, and system (not in Q1)

Risk identification, risk assessment, and risk mitigation measures are taken by all regions. African organizations establish cross-functional teams to lead response activities. China invests in training to build key know-how. Europe/North America, India/Pakistan, and Iran redesign their business models. Incident response and contingency plans are developed. End-to-end risk identification and assessment is important in building resilience. This is done by establishing risk management systems in enterprises. In Africa, knowledge of experts is used to increase SC resilience, and Brazil and Europe/North America diversify their SCs to reduce dependencies. When restoring their operations, firms analyze the situation and the specific risks in their SCs and monitor the course of the pandemic. China uses travel and contact monitoring data to manage the restoration of business operations.

SC disruptions/ SC disturbances (only in Q1)

Long-lasting disruptions arise from demand fluctuations caused by panic purchases, increased demand for essential products, and decreased demand for non-essential goods. Closed borders, prolonged disruptions in transportation, and plant closures cause shortages of raw material and finished products. Reduced orders lead to insufficient production capacity utilization in China and Europe/North America. In particular, experts from China report major problems caused by sudden demand drops. Difficulties resulting from disturbances arise primarily within transportation. Longer lead times and delays arise from illnesses of drivers, quarantine regulations, and increased waiting times at borders.

Logistics

Logistics challenges arise from travel and transport restrictions such as closed borders or regulations and lead to difficulties in reaching customers and markets. Limited availability of logistics staff and scarce transport options amplify the criticality of the situation. Firms increase cooperation with logistics service providers or switch to alternative transport options in order to improve their logistics performance. In warehousing, safety stock is increased, and stock keeping units are reduced. Firms increase SC resilience by diversifying and expanding their logistics network and by updating their inventory and planning policies and rethinking just-in-time (JIT) solutions. Especially in Europe/North America, companies resort to alternative transportation options and increase safety stock levels for critical components in order to restore business activities.

Digitalization

In response to vulnerabilities caused by COVID-19, companies improve SC resilience and restore operations by moving to online platforms and building up IT capabilities. With these measures, firms adapt to changing work demands and digitally transform their business (Holmström *et al.* 2019). System solutions include virtual collaboration tools, e-commerce platforms, teleworking opportunities, reliable enterprise resource planning systems, and tracking devices. SC digitalization measures are taken often in Africa, India/Pakistan, and Iran. In Brazil, digital issues arise from lacking SC transparency and low SC governance. For China, improving SC visibility is of high importance to build resilience.

Finance

In Africa and Iran, financial challenges are caused by reduced sales that result from decreased purchasing power of customers, closed shops, and increased efforts to reach customers. Hygiene regulations cause increased expenses in China and Europe/North America. Lack of investment is challenging in Europe, while unavailability of capital is causing major problems in Brazil. Enterprises in Africa and Europe/North America apply for financial support or receive money from insurance policies in order to deal with the financial challenges. Salary cuts and employee dismissals as well as the sharing of transport vehicles between firms are prominent measures to reduce costs in Africa, India/Pakistan, and Iran. Companies implement a robust cash flow management and build up capital reserves to improve SC resilience. China enforces stricter cost controls and changes product prices to restore operations.

Government

Rising unemployment and poverty pose challenges to people, firms, and SCs. Governments support the enterprises through financial means and provide the usage of state facilities. Only the experts from India/Pakistan and Iran refer to the construct of governmental regulations as a source of vulnerabilities. In Africa, governments play an important role in equipping local health facilities and regulate rationing to ensure that even the poorest receive the most basic necessities. One expert from North America refers to the usage of government support to build up SC resilience. To restore operations in China, the government is mainly responsible for ending lockdowns and shutdowns and for approving the reopening of business. In Africa, the governments undertake inspections to ensure hygiene standards.

Summing up, the given answers and provided arguments are in line with existing debates on SC risk and resilience, although the HRM construct is typically not mentioned in extant literature (see e.g. Ellis et al. 2011 or (Xu *et al.* 2020b)). Other aspects receive more attention, which is emphasized further in the next steps of the study. Yet, analyzing this in greater detail adds further information and additional justification of the three polls of the Delphi study.

4.2. Frequency analysis

The aggregate and detailed results of the frequency analysis (see Table 5.3 and Table 5.4) illustrate commonalities and differences between the regional clusters.

Table 5.3: Aggregate results: Two highest-rated constructs and their numbers of occurrence per region, question, and process

Question	Source		Make		Deliver	
Q1: Vulnerabilities	SC disruption(s)	5	Workforce/ HRM	6	Logistics	6
	Finance	3	Finance	4		
Q2: Responding measures	Supply network	5	Workforce/ HRM	4	Logistics	6
	Risk management	4			SC agility	3
Q3: Resilience building	Supply network	5	Supply network	4	Logistics	4
	SC agility	3	Digitalization	3	Supply network	4
	Risk management	3				
Q4: Restore operations	SC agility	4	Workforce/ HRM	5	Logistics	5
	Supply network	3	Government	3	Digitalization	4
					Supply network	3

Note: Since six regions are distinguished, a construct can occur a maximum of six times.

For the *Source* processes, all regions except Iran see SC disruptions as a major vulnerability and consider supply network as an important response measure and a strong lever for SC resilience. In contrast, Iran regards SC volatility as major source of vulnerability, logistics and digitalization as main response measures, and financial issues as building blocks for resilience in supply. Most important approaches to restore operations are based on SC agility (except Iran and India/Pakistan).

In Iran, China, and India/Pakistan, supply networks are also important for restoring operations, whereas only in Europe/North America risk management is perceived as a highly important factor of business restoration.

Table 5.4: Detailed results: The two highest-rated constructs per question and process in each region (Q1: vulnerabilities, Q2: responding measures, Q3: resilience building and Q4: restore operations)

Region	Question	Source	Value	Make	Value	Deliver	Value
Africa	Q1	Finance	59%	Supply network	41%	Logistics	56%
		SC disruption(s)	47%	Government	41%	SC disruptions(s)	53%
				Workforce/ HRM	41%		
	Q2	Government	59%	Digitalization	47%	Supply network	53%
		Supply network	53%	Supply network	41%	Logistics	47%
				Risk management	41%		
	Q3	Supply network	53%	Risk management	47%	Supply network	65%
		Digitalization	47%	Digitalization	47%	SC agility	53%
		SC agility	47%				
	Q4	SC agility	53%	Supply network	47%	Supply network	53%
		Digitalization	53%	Digitalization	41%	Dig./ SC agil./ Fin./ Log.	35%
				Government	41%		
Brazil	Q1	SC disruption(s)	50%	Workforce/ HRM	55%	Logistics	50%
		Finance	50%	Logistics	40%	Supply network	40%
	Q2	Supply network	55%	Workforce/ HRM	55%	SC agility	60%
		Risk management	55%	SC agility	45%	Logistics	55%
				Logistics	45%		
	Q3	Supply network	65%	Logistics	55%	Supply network	45%
		Logistics	45%	Digitalization	55%	Digitalization	45%
	Q4	Finance	50%	Workforce/ HRM	55%	SC agility	55%
		SC agility	45%	Risk mgmt./ Sup. net./ Log.	40%	Digitalization	55%
China	Q1	SC disruption(s)	81%	Workforce/ HRM	88%	Logistics	94%
		Government	44%	Finance	56%	SC volatility	50%
		Logistics	44%				
	Q2	Supply network	75%	Workforce/ HRM	81%	Logistics	94%
		SC agility	69%	SC agility	56%	Supply network	69%
				Finance	56%		
	Q3	Supply network	88%	SC agility	63%	Supply network	69%
		Risk management	75%	Supply network	56%	Logistics	69%

	Q4	Supply network	75%	Workforce/ HRM	81%	Supply network	69%
		SC agility	63%	SC agility	63%	Logistics	69%
Europe & North America	Q1	SC disruption(s)	61%	Finance	57%	Logistics	38%
		Supply network	41%	Workforce/ HRM	50%	SC disruption(s)	35%
	Q2	Supply network	62%	Workforce/ HRM	54%	SC agility	41%
		Risk management	46%	Government	51%	Logistics	32%
	Q3	Supply network	65%	SC agility	43%	SC agility	46%
		Risk management	46%	Supply network	41%	Logistics	43%
		SC agility	46%				
	Q4	SC agility	51%	Government	51%	Logistics	51%
		Risk management	46%	Workforce/ HRM	46%	Digitalization	41%
India & Pakistan	Q1	SC disruption(s)	61%	Finance	56%	Logistics	67%
		SC volatility	44%	Workforce/ HRM	50%	Supply network	44%
	Q2	Logistics	56%	Workforce/ HRM	50%	SC agility	56%
		Sup. net./ Dig./ Risk mgmt.	39%	Finance	50%	Logistics	56%
	Q3	Supply network	50%	Digitalization	50%	Logistics	61%
		SC agility	50%	Supply network	39%	Supply network	50%
				Finance	39%		
	Q4	Digitalization	44%	Workforce/ HRM	61%	Supply network	56%
		Gov./ Sup. net./ Fin.	39%	SC agility	39%	Logistics	50%
Iran	Q1	Finance	56%	Finance	63%	Logistics	44%
		SC volatility	50%	Workforce/ HRM	63%	Digitalization	38%
						Government	38%
	Q2	Risk management	38%	Risk management	63%	Digitalization	56%
		Logistics	31%	Supply network	56%	Logistics	50%
		Digitalization	31%				
	Q3	Finance	44%	Supply network	69%	Logistics	50%
		Risk management	31%	Finance	56%	Digitalization	44%
	Q4	Logistics	44%	Government	63%	Digitalization	50%
		Supply network	38%	Risk management	56%	Logistics	44%
				Workforce/ HRM	56%		

For the *Make* processes, workforce/HRM is the undisputed major source of vulnerability in all regions. However, in Africa and Iran this factor is not considered a priority issue for response measures and restoring operations, and no region considers this factor as an important lever for SC resilience. Important SC resilience factors vary from supply networks (all regions except Africa and Brazil) and digitalization (China, Iran and Europe/North America) over SC agility (China and Europe/North America) and finance (India/Pakistan and Iran) to logistics (Brazil) and risk management (Africa).

For the *Deliver* processes, logistics is – not surprisingly – the most important source of vulnerability and response measure and a key lever for SC resilience (except in Africa and Brazil) and restoring operations (except in Brazil). Further vulnerability sources include SC disruptions (Africa and Europe/North America), supply networks (Brazil and India/Pakistan), and SC volatility (China) as well as digitalization and government (Iran). Possible response measures comprise SC agility (India/Pakistan, Europe/North America, Brazil), supply networks (China and Africa), and digitalization (Iran). Supply networks are also often seen as an important factor of SC resilience. Exceptions represent Europe/North America with SC agility and Iran with digitalization. Digitalization, in turn, is in most regions important to restore operations. India/Pakistan and China as highly digitalized economies represent the only regional exceptions.

4.3. Cluster analysis

The cluster analysis combines the regions that are similar within one cluster and at the same time forms individual clusters that differ from each other as much as possible.

As shown in Table 5.5, four clusters are formed for vulnerabilities, response measures, and restore operations, while the regional split for SC resilience comprises only three clusters. The clusters for Q1 and Q2 are identical, which indicates a large geographical similarity with regard to vulnerabilities and initial response measures. Differences in the clustering for Q3 and Q4 suggest further geographical particularities in the factors of SC resilience and restoring operations because else the clustering would not change compared to Q1 and Q2. Table 5.5 also shows that China always represents a cluster of its own and that Iran also is unique with regard to vulnerabilities, response measures, and SC resilience. Brazil forms its own cluster in restore operations and else is grouped with Europe/North America and India/Pakistan. The largest homogeneity is detected in SC resilience factors where only China and Iran stand out as two separate single-country clusters.

Table 5.5: Clusters in Q1: vulnerabilities, Q2: responding measures, Q3: resilience building, and Q4: restore operations.

Question & cluster		Africa	Brazil	China	EU/NA	IND/PAK	Iran
Q1: Vulnerabilities	C1		X		X	X	
	C2	X					
	C3			X			
	C4						X
Q2: Response measures	C1		X		X	X	
	C2	X					
	C3			X			
	C4						X
Q3: SC resilience	C1	X	X		X	X	
	C2			X			
	C3						X
Q3: Restore operations	C1	X				X	
	C2				X		X
	C3		X				
	C4			X			

In the following, the clusters are presented for each question. Table 5.6 shows the characteristic items per cluster, i.e., the constructs that differ most markedly from the results of the other clusters.

Table 5.6: The three highest t-values per cluster in Q1: vulnerabilities, Q2: responding measures, Q3: resilience building, and Q4: restore operations. High t-values indicate that there is an overrepresentation of the item related to the process in the cluster compared to the other clusters. SC disruption(s) and SC disturbance(s) only appears in Q1 and risk management culture, knowledge, and system only in Q2 to Q4.

Construct & Question		*Source*	*Make*	*Deliver*
Digitalization	Q1		Brazil, E&NA, I&P	Iran
	Q2		Africa	
	Q3			
	Q4	Africa, I&P	Africa, I&P	Brazil
Finance	Q1			Africa
	Q2			Iran
	Q3	Iran		
	Q4		China	
Government	Q1		Africa	
	Q2	Africa		Africa
	Q3	Afr., Bra., E&NA, I&P	Iran	Afr., Bra., E&NA, I&P
	Q4	Africa, I&P	E&NA, Iran	
Logistics	Q1			China
	Q2		Brazil, E&NA, I&P	China
	Q3	Afr., Bra., E&NA, I&P		China
	Q4	E&NA, Iran	Brazil	China
Risk management culture, knowledge, and system	Q2	Brazil, E&NA, I&P	Iran	
	Q3	China		
	Q4		E&NA, Iran	
SC disruption(s)	Q1			Africa
SC disturbance(s)	Q1	Iran	Brazil, E&NA, I&P	
SC volatility/ agility	Q1	Iran		China
	Q2	China		Brazil, E&NA, I&P
	Q3		China	
	Q4		China	Brazil
Supply network	Q1			

	Q2 Q3 Q4		Iran Iran	China
Workforce/HRM and hygiene management	Q1 Q2 Q3 Q4		China	Brazil, E&NA, I&P

Q1 Vulnerabilities:

The cluster analysis regarding the question of vulnerabilities results in four groupings: (1) Africa, (2) Brazil, Europe/North America, and India/Pakistan, (3) China, and (4) Iran. With challenges associated to governmental regulations in *Make* and with comparatively high SC disruptions and financial challenges in *Deliver*, Africa stands out from other regions. Brazil, Europe/North America, and India/Pakistan have in common and thus differ from the other regions that they face challenges in workforce/HRM and hygiene management in *Deliver* and challenges in digitalization and SC disturbances in *Make*. China is confronted with outstanding vulnerabilities in workforce/HRM and hygiene management during *Make* and logistical challenges and SC volatility during *Deliver*. SC volatility and SC disturbances complicate the sourcing process more strongly in Iran than in any other cluster. Challenges in digitalization represent *Deliver* vulnerabilities of Iranian SCs.

Q2 Response measures:

African countries stand out as they intensify measures to improve *Source* and *Deliver* by receiving governmental support and to enhance digitalization in *Make*. The response measures of Brazil, Europe/North America, and India/Pakistan differ from other regions in the way that they increasingly establish risk management culture, knowledge, and system within *Sourcing*, improve logistics performance in *Make*, and increase SC agility within *Deliver*. China improves the *Sourcing* process by increasing SC agility and *Deliver* activities by improving logistics performance and by strengthening supply network adaptation and collaboration. Iran stands out from the other regions as it focuses in *Make* on strengthening supply network adaptation and collaboration and establishing risk management culture, knowledge, and system. The experts indicate outstandingly high values in improving financial management in *Deliver*.

Q3 Resilience building:

For SC resilience building the cluster analysis reveals that Africa, Brazil, Europe/North America, and India/Pakistan form one cluster, while China and Iran stand out as two individual single-country clusters. The first mentioned cluster places greater emphasis on improving logistics

performance in *Source* and receiving governmental support in *Source* and *Deliver*. China relies on establishing risk management culture, knowledge, and system in *Source* to build resilience, on increasing SC agility in *Make*, and on improving logistics performance in *Deliver*. Iran differs from the other countries as it focuses its resilience building activities in *Source* increasingly on improving financial management and in *Make* on strengthening supply network adaptation and collaboration as well as receiving government support .

Q4 Restoring operations:

The cluster analysis reveals that for restoring operations Africa and India/Pakistan are distinguished by a higher focus on enhancing digitalization in *Source* and *Make* and receiving governmental support in *Source*. Brazil improves logistical performance in *Make,* and it increases SC agility and enhances digitalization in *Deliver*. In contrast to the other clusters, China strongly counts on strengthening SC agility and financial performance in *Make* and improving logistics performance in Deliver to restore operations. Europe/North America and Iran differ from the other clusters by improving logistics performance in *Source* and by establishing risk management culture, knowledge, and system with governmental support in *Make*.

The results of the cluster analysis show that regional differences are particularly evident in three constructs: logistics, government, and SC agility. Comparably high values in the logistics constructs arise in Europe/North America in *Source* and in Brazil in *Make*. China stands out clearly from the other regions, as the experts give outstandingly high values for logistics in *Deliver* within all questions. The experts attach above-average importance to receiving government support in India/Pakistan in *Source,* in Africa in *Source* and *Deliver,* and in Iran in *Make*. China increases SC agility comparatively high in *Make*, while Brazil stands out in *Deliver*. Iran is distinct from the other regions, especially in *Make*. In addition to government support, strengthening supply network adaptation and collaboration and establishing risk management culture, knowledge, and system are more relevant for Iran than for the other regions. Africa stands out due to a higher focus on digitalization in *Make*.

5. Discussion

Our study identified interesting and region-specific insights associated with risk and resilience of SCs in connection with the COVID-19 pandemic. This contributes to a more holistic picture of the impacts of COVID-19 and the measures taken to repond to disruptions, build resilience, and restore operations. This study thereby contributes to advancing a regionally differentiated

comprehesion of SC risk and resilience management. While the COVID-19 pandemic offers a kind of a magnifying glass perspective, the underlying issue among the regions call for a better comprehension of when SCs can be managed in a unified manner and when regional specifics and particularities have to be taken into account. This extends previous research, which did not distinguish different regions (Ellis *et al.* 2011; Xu *et al.* 2020b).

5.1. Vulnerabilities

This study revealed that vulnerabilities within the COVID-19 pandemic are mainly caused by long-term SC disruptions, financial, HRM, and logistical challenges (Table 5.3:). It showed that SC disruptions are particularly prevalent in *Source*, which could be explained by China's importance as a center of global economic manufacturing. The outbreak in China led to international spillovers, particularly in international trade, mobility, finance, and commodity markets (Deloitte, 2020). Due to the dependencies on China as a production location, other importing countries also face disruptions on the supply side of SCs.

Furthermore, lockdowns with closed stores and restaurants and with people staying and working at home caused sharp declines in commercial demand and strong increases in private demand and, thus, increased demand uncertainty in both channels (Sodhi and Tang, 2021). E-commerce offerings and home delivery services were increasingly used. These changes in the pattern of consumers and SCs are likely to continue in the future (Nikolopoulos *et al.* 2021), therefore causing long-term shifts and disruptions. The study findings thereby help to explain how SC structures and operations might be adapted to cope with external shocks (Akkermans and van Wassenhove, 2018).

Financial challenges arise, as shown, from declining sales and increased fixed costs. Measures such as order cancellations or unpaid invoices, which were suggested by the experts in this study, can lead to liquidity problems for suppliers, who in turn cannot pay their suppliers. Lack of financial support can lead to longer recovery times for SCs because suppliers are limited in their ability to increase production (Tang and Yang, 2020).

The unforeseeable reduction in labor supply due to sick workers is confirmed in other studies (e.g. Sodhi and Tang, 2021). Given the unpredictable course of the pandemic, companies will be confronted with uncertain workforce availability in the long term, even despite the introduction of hygiene measures. The pandemic emerged in China, where production was the first to be shut down, while companies in other countries continued to operate. Due to stockpiles within the SCs and orders that had already been shipped, the spillover effects were delayed by the production

disruptions in China. When the flow of materials was interrupted, SC shocks occurred (Govindarajan and Bagla, 2020), and companies faced insufficient production margins (Handfield *et al.* 2020), among other issues named in this study.

The situation was further complicated by the fact that logistics and transport capacity was already scarce before the pandemic as Yoon *et al.* (2016) point out. Due to the decline in air passenger traffic, the available capacity for freight decreased, which intensified the situation and raised prices. Demand uncertainties and lack of transparency within SCs encourage misplanning and insufficient transportation capacity (Tang, 2006). Especially for companies that have implemented JIT manufacturing and thus reduced inventories in their system, unforeseeable transportation delays are a vulnerability.

5.2. Response measures, resilience building, and restoring operations

In nearly all regions, strengthening the supply network and improving logistics performance have emerged as important measures to respond to the pandemic, to build resilience, and to restore operations. The importance of supply networks is confirmed by, inter alia, Alicke et al. (2020) who link close supplier coordination to increased SC resilience. Collaborations and close relationships enable faster recovery from disruptions (Paul and Chowdhury, 2021). Sharma *et al.* (2020) recommend synchronizing the strategic processes, and Jabbour *et al.* (2020) emphasize knowledge and information sharing. The creation of open communication and information channels was underlined by the experts in this study.

Even before the pandemic, political framework conditions (e.g. tariffs), rising transport costs, and environmental concerns have provoked discussions on shortening SCs (Sodhi and Tang, 2021). COVID-19 has further shown the negative aspects of globalized SCs, and the calls for localization have been raised in this study, especially in Africa and Europe/North America. Based on interviews with SC managers, Ivanov and Das (2020) identify localism as a key issue when redesigning SCs. Local SCs have the advantage that transport distances are shortened, and costs are reduced, less lead time is needed, and customer requirements can be met more quickly. In addition, local SCs are easier to manage, and dependencies on China or other countries are reduced (van Hoek and Dobrzykowski, 2021; Sauer *et al.* 2022). But local SCs cannot take advantage of the market benefits of the globalized world, such as a diverse sourcing base (Choi *et al.* 2021) or lower costs, which puts companies under high pressure to use their capacities efficiently in order to remain competitive (Shih, 2020). Radical changes to the SC are complicated and come with major

challenges (Sodhi and Tang, 2021) as it impacts suppliers, third-party service providers, and customers (Zinn and Goldsby, 2020). An alternative strategy is the diversification of supplier locations (Pettit *et al.* 2019), which has been frequently mentioned by the experts in this study. This result confirms prior studies (e.g. Kahiluoto *et al.* 2020). The expansion of SCs to include alternative suppliers serves to avoid production losses and reduces dependencies (van Hoek, 2020; Shih, 2020). However, there are risks associated with integration. A balance between domestic production and global trade will be critical for reducing uncertainty in the future and thus creating resilient supply networks (Choi *et al.*, 2021).

Increasing SC agility is a measure that many regions implement and that in scientific literature often is associated with the supply network. According to Ivanov (2020b), flexible supply network structures that quickly can be redesigned are crucial for a rapid recovery. A company's agility always depends on the responsiveness of its SCs. In this context, visibility and velocity are crucial (Christopher and Peck, 2004). In addition to building safety stock and pooling to reduce volatility, companies implement options to make capacity more flexible (Chopra and Sodhi, 2004). Experts indicated that companies simplify products and reduce supply. This shortens changeover times and increases production volumes, which aims to meet the increased demand for essential products.

5.3. Region-specific characteristics

The results of the cluster analysis revealed that Africa, China, and Iran differ significantly from the other regions. This is a unique extension of our knowledge about SC impacts of the pandemic because other studies that provide a structured global comparison are scant. Yet, the study at hand offers insights beyond the pandemic as underlying conditions of the geographical regions are equally evident.

Africa faces multiple political, socio-cultural, and economic challenges, which hamper the implementation of the required COVID-19 measures (Waya *et al.* 2021). Low living standards and limited infrastructure, especially in the healthcare industry, make many African countries vulnerable to the impacts of the pandemic. Countries with weak health infrastructures and political structures, as well as already existing vulnerabilities in the financial sector, are particularly exposed to movements in the global markets (Utz *et al.* 2020). Results for Africa differ from those for the other regions, especially concerning the finance construct. Africa has a high dependence on international trade and foreign financing. Governmental support in *Source* and *Deliver* and the digitalization in *Make* are important. Governments can stimulate the economy or issue guidelines

to regenerate industries and societies, and legal authorities should provide financial, fiscal, and industrial support to businesses (Sodhi and Tang, 2021). Although SCM and logistics in African countries differ from the ones in industrialized regions and emerging economies, studies on operations and SCM research in Africa are scant (El Baz and Ruel, 2021). Since only a few SCM studies focus on Africa, ample opportunties for future research exist.

COVID-19 emerged first in Wuhan, and China was confronted with the effects of the pandemic earlier than other countries and regions. With the growing spread of the pandemic, new business models and ways of teamwork had to be tested, previously unknown customer needs had to be met, and innovative business processes and practices had to be developed (Narayandas *et al.* 2020). While the pandemic was spreading and all other regions were struggling with the first waves of infection, China was able to contain the pandemic after the outbreak, increasingly isolating itself, and, thus, was able to return to normality faster than other regions, which was then challenged by COVID-19 variants in later stages of the pandemic. China is a major producer of components and products. As situations in supply countries are constantly changing, it is critical to make production as agile as possible, which could explain China's increased focus on the SC agility in *Make* and logistics in *Deliver*. Yang *et al.* (2020) state that little empirical research exists on the current situation of Chinese manufacturers, which have faced staff shortages and a lack of foreign production orders.

Since 1980, Iran has been under multiple sanctions, which cover almost all sectors and have been further intensified by the USA in the last two years (Danaei *et al.* 2019). These measures have not only excluded Iran from the global financial market, reduced exports of oil from Iran, and confronted the economy with harsh business conditions, but have also restricted access to medical equipment (Takian *et al.* 2020). As a result, the situation of the health system was already fragile before the outbreak of COVID-19 (Karimi and Haghpanah, 2015). The pandemic has further exacerbated this situation, as the government cannot rely on measures taken by other countries, such as raising funds or importing essential goods, due to the sanctions (Danaei *et al.* 2019). The country's isolated position can explain the study's finding that Iran differs in many aspects of manufacturing processes. The country shows comparably high vulnerabilities due to SC volatility and the increase of SC agility as counter measures.

Regional specifics and particularities in SCM should also be reflected in Europe/North America, Brazil, and India/Pakistan, respectively. When being transferred to contexts of emerging economies such as Brazil or India/Pakistan, structures, systems, and processes that perfectly suit SCs in

industrialized regions of Europe and North America must be adapted or changed under consideration of context-specific factors and regional particularities. India is characterized by a comparably low level of SCM adoption with practices lagging behind developed economies and with challenges that arise from inter-organizational collaboration, communication, and coordination problems (Sahu et al. 2021). Brazil has to deal with difficulties in infrastructure for telecommunication and transport, and it also faces sustainability challenges and shortcomings in the workforce (Pires, 2015). Although Brazil and India/Pakistan share many frame conditions of emerging economies and similarities in vulnerabilities, response measures, and SC resilience, not all SCM approaches can be used interchangeably for both regions without reflecting context-specific factors. The observation that Brazil stands out as a single cluster with regard to restoring operations shows this clearly.

6. Conclusion

The COVID-19 pandemic has impacted SCs across the globe. It provides a unique opportunity to explore how companies and their management in different regions respond to and perform in this unprecedented situation. The employed method, a three-round Delphi study, deepens the understanding of the impacts. The research design enables a comprehensive and region-specific insight into SC vulnerabilities and response measures to improve resilience and to restore operations. The main findings are summarized as follows.

The content analysis of the first round survey resulted in ten major issues in SCs: (1) digitalization, (2) finance, (3) government, (4) human resource and hygiene management, (5) logistics, (6) risk management culture, knowledge, and system, (7) SC volatility/agility, (8) SC disruption(s), (9) SC disturbance(s), and (10) supply network. They were framed against the SCOR processes: *Source*, *Make*, and *Deliver*. Closed borders and restricted freight transport represent major challenges that arise from the COVID-19 pandemic and that cause SC disruptions and disturbances in developing and emerging regions. As a response, companies strengthen their supply network, and an increasing number of corporations diversify their SCs, create open communication and information channels, and take measures such as nearshoring, reshoring, or local sourcing. These measures are also important to build resilient SCs, together with end-to-end risk identification and assessment. Firms restore operations by redesigning SCs, implementing hygiene regulations, and teleworking, as well as by analyzing risks and monitoring the course of the pandemic.

The frequency analysis illustrated the region-specific characteristics and indicated regional similarities. The main vulnerabilities are long-term SC disruptions, challenges in workforce/HRM, financial, and logistical challenges. As a response measure, to build resilience and to restore operations, strengthening the supply network has emerged as particularly significant. Many regions implement measures to increase SC agility and improve logistics performance.

The cluster analysis revealed various regional differences. Africa, China, and Iran are distinguished from the other regions considered. For Africa, governmental support in *Source* and *Deliver* and the digitalization of *Make* are more important. China stands out due to increased problems and strengthening measures in logistics within *Delivery*. Iran shows several differences in *Make*, and the experts indicate that the construct SC volatility/ agility is of high importance.

This paper contributes to the resilience literature in the context of extreme situations. Given that extreme events will become more frequent in the future, insights into how SCs can be managed under such exceptional conditions are crucial. The regional insights gained in this study contribute to a more detailed and holistic picture of the impacts of COVID-19 and the measures taken to respond to disruptions, build resilience, and restore operations. This will serve both companies to build more resilient SCs and policy makers to take supportive measures.

However, limitations must be recognized. First, the content analysis faced a wide variety of answers, which the authors condensed to only ten constructs evident across all regions, while leveling out regional specificities and thus reducing the level of detail of the results. Moreover, the selection of the SCOR processes establishes a certain analysis frame that is not allowing full freedom for the results.

Second, the COVID-19 pandemic is not yet overcome, and the conditions change constantly. This means that the study was conducted in a dynamic environment, which is why the thematic focus can change in the course of the study, which took place over a period of nine months. Different time paths can be observed. For example, while the number of cases peaked in Europe and North America between May and July 2020, the first cases were reported in Africa. Therefore, when the first round survey was conducted in June 2020, the effects of COVID-19 on African economies were still to unfold. As the pandemic is continuing, it is difficult to completely predict how the situation will develop, which long-term consequences will occur, and how companies will react to survive the disruption and build resilient SCs.

This study has identified a need for further research. For organizations, a strong supply network is critical to manage risks. A closer look at which of the supply network and collaboration practices

would be appropriate for extreme situations such as the COVID-19 pandemic could be helpful. In this context, there is a lack of insights on the impact of SC relocations on the supply network and affected countries. As Africa, China, and Iran stand out from other regions, a closer look at these regions could be profitable.

6. Analysing developing countries approaches of supply chain resilience to COVID-19

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Abstract

Purpose – The Covid-19 pandemic has made it essential to explore the resilience factors specific to developing regions, not only because they pose threats of extreme poverty and offer a novel context but also because they play an important role in globalisation.

Design/methodology/approach – A mixed-method approach was undertaken to address this novel pandemic situation. First, an open-ended structured questionnaire was developed, and data were collected from three neighbouring emerging economies: Pakistan, India and Iran. Experts' perspectives on vulnerabilities, response measures, resilience and restoration of supply chain activities, and the role of social capital were collected. Second, building upon the findings from phase one of the studies, a quantitative structured questionnaire using the supply chain operational reference (SCOR) model was used to collect data in a structured manner. This quantitative data were further analysed using frequency and contingency analysis.

Findings – The findings from the first phase of the study inductively derive 36 resilience categories. Later, the contingency findings show that supply chain (SC) disruption is a major vulnerability for emerging economies, whereas solutions offered to combat it lay in the reconfiguration of resources, such as financial, technological, human, information and material. Additionally, supply network structure and social capital play an integral part in making SCs resilient against disruption.

Research limitations/implications – The respondents comprise the academics/SC researchers, which make the findings interesting though they lack the industrial experts' perspectives, directly. Nevertheless, the propositions can be tested in industrial settings to see whether the results are limited to a specific industrial setting or are rather generalised.

Practical implications – Similarly, practitioners and policy makers can incorporate the SCOR metrics/factors outlined in this study into their performance measurement systems and ensure continuous monitoring for firm's resilience.

Originality/value – The study offers a holistic understanding of the developing regions' approaches to Covid-19. The paper also takes a social capital perspective to explain firms' resilience in these emerging economies.

Keywords Supply chain, Resilience, Disruption risk, Social network theory, Social capital

1. Introduction

Covid-19 has confined supply chains (SCs) to their geographical boundaries and has restricted operational activities within regions to control the spread of the virus. These restrictions have not only hampered the performance of global but also local SC operations by disrupting the link between demand and supply within regions (Salvato et al. 2020; Butt, 2021; Paul and Chowdhury, 2020; Ruel et al. 2021; El Baz and Ruel, 2021; Wieland and Durach, 2021). Therefore, timely restoration of operational activities within countries is important.

A significant shift in SC operations is specifically observed in countries where the majority of the population is relatively poor and usually comprises the labour class (Prahalad, 2005). To contain the local spread of the disease, the governments of emerging countries have imposed lockdowns, which means there are fewer chances for the labour class to earn their living. Therefore, a large part of the labour class might lose income opportunities, thus pushing them into extreme poverty and creating long-lasting issues of social sustainability. These emerging economies already lack efficient operational activities due to ingrained infrastructural challenges and political instability (Rehman et al. 2020; Parmigiani and Rivera-Santos, 2015). The market environments in developing countries are relatively different from those in developed countries; therefore, a novel solution is a requisite for making firms resilient in these regions.

Furthermore, most resource-based global SCs belong to developing regions (Silvester, 2015). The majority of the actors within these SCs are either from rural populations or comprise small and medium enterprises with limited access to basic business opportunities (i.e. lack of finance). A prolonged halt of operational activities could initially pose financial challenges to this group and could become a barrier to income opportunities resulting from globalisation after pandemic.

Therefore, these countries require specific scrutiny for the timely restoration of their activities and make it mandatory to evaluate the resilience of the firms operating there.

The social, psychological and economic perspectives on resilience describe it as the capability of a social system to increase its capacity to learn from past disasters, protect itself better in the future, and reduce its level of risk (Adobor, 2020; Melnyk et al. 2014). It is also often linked to the tenets of SC vulnerabilities (Svensson, 2002; Ali and Gurd, 2020; Wong et al. 2020), where vulnerabilities can be measured in terms of risks posed to the SC(s) (Pettit et al. 2010). Therefore, the resilience concept includes knowing the vulnerabilities and factors necessary for taking risk response measures, mitigating future risks and restoring activities to overcome these vulnerabilities.

Amongst all the factors or capabilities of resilience, social capital is a noteworthy capability in recent Covid-19-related literature, which argues for its importance in SC resilience (Lang et al. 2021; Butt, 2021; Ali and Gurd, 2020; Ivanov and Dolgui, 2020). However, how social capital can help make firms resilient, specifically in emerging economies, requires more understanding. A prominent lens for developing such understanding is social network theory (SNT) and its importance in resilience literature is often argued (Adobor, 2020; Granovetter, 1992). Therefore, taking the SNT lens together with the social capital perspective would generate valuable insights.

In sum, the resilience of firms specific to developing countries is important for two reasons. First, they pose long-lasting challenges of social sustainability and proffer a novel context and second, they play an integral part in restoring global SC operations (Silvestre, 2015). The Covid-19 pandemic has unique implications (Ivanov, 2020), which means it might have unique implications for developing countries as well, where resilience concept has rarely given importance which highlights an important gap in the literature. Exploring the resilience concept and finding context-specific factors would fill in this gap. Furthermore, recent Covid-19 literature highlighted the importance of social capital in building resilience but is limited in its further exploration (Lang et al. 2021; Butt, 2021). Therefore, the paper provides specific and detailed insights from emerging economies by filling these gaps in the literature and incorporating social capital's role in overcoming vulnerabilities. We address one research question (RQ) and two sub-questions, as follows:

RQ. What factors can make SCs in emerging economies more resilient?

(1) What factors are important in addressing SC vulnerabilities?

(2) How does social capital help address vulnerabilities in such contexts?

The subsequent structure of the paper comprises a brief literature review and a methodology section, followed by the findings from the analysis. After that, the findings are interpreted using SNT. These findings are then discussed, along with the limitations and future research directions. Lastly, a conclusion is drawn.

2. Literature review

Resilience evolved from the risk management literature and is often linked to its premise (Pettit et al. 2019). Two factors stimulating the application of SC resilience include outsourcing and opportunism (Pettit et al. 2019). First, with the increase in outsourcing, the management of SC has become more turbulent, leading to more disruptions throughout the SC because of a higher dependence on suppliers and keeping informed about the activities beyond first-tier suppliers. This, in turn, decreases flexibility, erodes buffers and increases volatile conditions. Second, risk management is a strategic process for identifying risks and formulating strategies to achieve an acceptable level of risk, where mostly risks are viewed independently and hidden interactions are hardly identified (Pettit et al. 2019; Fan and Stevenson, 2018). Therefore, the traditional risk management approach has been enhanced by the resilience approach due to the frequency and impact of unexpected events (Pettit et al. 2019; Khan and Burnes, 2007; Ponomarov and Holcomb, 2009; Melnyk et al. 2010). These risks are identified as vulnerabilities in resilience literature (Sevensson, 2002), which include but are not limited to SC disruption, sensitivity, resource limits, external pressures, deliberate threats and turbulence (Pettit et al. 2010). Therefore, the first component of resilience is identifying vulnerabilities.

Resilience is a widely defined concept that can be seen in physical, psychological, economic, engineering, disaster management, organisational, ecological and socio-ecological research (Svensson, 2002). It was introduced as a concept in ecological literature and later shifted to SC literature. From an ecological perspective, it is defined as the “degree, manner and pace of restoration of initial structure and function in an ecosystem after disturbance” (Westman, 1978, p. 705). Nevertheless, one of the earliest definitions of SC resilience emerged in the work of Christopher and Peck (2004). They defined it as “an ability of the system to return to its original state or move to a new more desirable state after being disturbed” (p. 4). Later, Fiksel (2006) defined it as “the capacity for an enterprise to survive, adapt and grow in the face of turbulent change” (p. 16). It has recently been mentioned as a system’s latent ability to endure despite adversity and to recover and maintain its existing structure after a shock, thereby having

characteristics of flexibility and stability (Sajko et al. 2021; de S_a et al. 2019). Thus, the companies seek equilibrium to operate efficiently amid disruptive events. The equilibrium can be achieved by analysing SC vulnerabilities and related capabilities to find a balance between profits and risks (Pettit et al. 2019). Therefore, the resilience concept also includes taking risk response measures, mitigating future risks and restoring activities to overcome these vulnerabilities.

Furthermore, these definitions of resilience have been offered over the years, considering both the ex ante (before the disruptive event) and ex-post (after the disruptive event) concepts of resilience (Iftikhar et al. 2021). Taking such a perspective, the literature mentions several capabilities as part of SC resilience (Pettit et al. 2019). However, there exists contradictory evidence as to how a company and its SC can build or enhance resilience (i.e. Pettit et al. 2010; Hohenstein et al. 2015). The most prominent capabilities, including flexibility, redundancy, collaboration, visibility, agility and multiple sourcing, were identified as resilience capabilities (Hohenstein et al. 2015; Sajko et al. 2021). Other capabilities identified in the literature include capacity, culture, inventory, information sharing, flexibility, redundancy, visibility, collaboration and agility/responsiveness (Ali et al. 2017). According to recent resilience literature, SC network design through configuration is the most important capability (Ivanov, 2020; McKibbin and Fernando, 2020; Son et al. 2021). However, flexibility, redundancy, collaboration, velocity, IT capability, robustness and visibility are the most cited resilience capabilities in the literature over the years (Ponis and Koronis, 2012; Hohenstein et al. 2015; Tukamuhabwa et al. 2015; Ali et al. 2017). Therefore, due to inconsistency and lack of coherence amongst resilience researchers regarding which capabilities are most important, it is paramount to explore which factors are essential for current risk response measures and future risk mitigation in emerging economies.

In the literature on emerging economies, uncertainty is often linked to institutional voids (Rehman et al. 2020), but the resilience concept is rarely addressed. Nevertheless, a prominent link between these two-literature streams is that social capital is found to be a prominent capability of the system in combating ingrained challenges (Ali and Gurd, 2020; Ivanov and Dolgui, 2020; Son et al. 2021; Sutter et al. 2014; Ansari et al. 2012). For example, Sutter et al. (2014) highlighted the fact that relational ties within these countries play a crucial role in overcoming sustainability challenges. Similarly, Shivarajan and Srinivasan (2013) emphasised the need to redesign SC infrastructure in developing countries and form strong network ties, because these ties can create normative and coercive pressures (Jajja et al. 2019). Furthermore, Aalbers and Smit (2020) asserted that these intra- and inter-organisational networks have the propensity to overcome a firm's

existing turmoil. Since the link between buyer and supplier has been disrupted by the pandemic (Butt, 2021; Paul and Chowdhury, 2020), taking a social capital perspective would generate an understanding of which network characteristics can help make firms resilient in emerging economies. The perspective includes three main categorisations of social capital: structural, cognitive and relational (Polyviou et al. 2019; Nahapiet and Ghoshal, 1998). The structural aspect is often linked to the network structure and is a proponent capability of resilient firms (Lang et al. 2021; Son et al. 2021; Luo, 2001). Moreover, the relational dimension is linked to trust and reciprocity enjoyed through personal relations, and the cognitive dimension is linked to collective goals and narratives (Polyviou et al. 2019; Sutter et al. 2014; Ansari et al. 2012). Therefore, analysing the role of social capital in relation to SC resilience in the current situation is likely to reap in-depth insights and thereby offer a background for the empirical study.

3. Methodology

The problem statement explicitly aimed to explore the underlying factors that can and are helping practitioners overcome vulnerabilities amid the pandemic. A single study design is insufficient to gather the necessary information (Wiedenmann and Gr€oßler, 2021) that can explain the novel situation in the underlying scenario. Therefore, this study follows a mixedmethod research design (MMD).

Morse and Niehaus define mixed methods as “the incorporation of one or more methodological strategies or techniques drawn from a second method, into a single research study, to access some part of the phenomena of interest that cannot be accessed by the use of the first method alone” (Morse and Niehaus, 2009, p. 9).When used in combination, quantitative and qualitative methods complement each other and allow for more robust analysis, taking advantage of the strengths of each (Green and Caracelli, 1997; Tashakkori et al. 1998). In mixed-method research, the taxonomy development model (Figure 1) is an exploratory design variant in which the quantitative study follows the qualitative study. In this design, researchers collect qualitative data to explore a unique idea (Creswell and Clark, 2007). As discussed, Covid-19 has unique implications (Ivanov, 2020), hence, exploring resilience amid such a situation is a unique idea. According to Creswell and Clark (2007), for an exploratory design, additional relevant considerations include that the research problem is more qualitatively oriented, that important constructs to study are unknown to the researcher, that time is not a barrier for conducting research in two phases and that new emergent taxonomy is identified based on qualitative results that cannot be answered with qualitative data.

This design is particularly useful when a researcher needs to identify important variables to study quantitatively when the variables are unknown (Creswell and Clark, 2007). As argued, the novelty of the pandemic emphasises exploring factors specific to the situation, thereby making the factors/constructs/variables unknown to the researchers and demands for qualitatively extracting these variables to quantitatively study the link between them, thereby fulfilling our research objectives. Accordingly, the analysis of data from the qualitative phase of the study highlighted that the variables are linked to three major processes, such as, source, make and deliver. To find which variable is important for which of the three operational processes, a supply chain operational reference (SCOR) model was further added into the quantitative study, i.e. creating classification of the variables (Figure 1). Additionally, the quantitative study aimed to achieve quantitative rigour for an exploratory method over a time span (Davis-Sramek et al. 2020; Wiedenmann and Großler, 2021). Therefore, the taxonomy development model from an MMD is a suitable method for the current study.

The study follows a structure presented in Figure 1, where the phases explain the sequence of both studies (i.e. the study started with the qualitative data collection, where respondents were interviewed using a questionnaire link sent via e-mail). As a result, qualitative data were collected (using online platform called SoSci survey) and then analysed using an inductive approach (for example, condensing the quotes from the respondents into constructs based on the definitions accumulated from the literature; see Table A1 in Appendix) (Saunders et al. 2009). The validity of the qualitative data was achieved by taking the definitions from existing literature and constructs mutually agreed upon by 15 supply chain management (SCM) researchers (Rehman et al. 2020). These constructs were then used to formulate a survey questionnaire, this time adding the SCOR classification model. The questionnaire allowed the respondents to check boxes, which according to them were the three most important constructs for each source, make and deliver process. The data were then analysed based on whether the construct was selected by the respondent or not (0s and 1s). Both qualitative and quantitative studies are explained in detail in subsequent paragraphs.

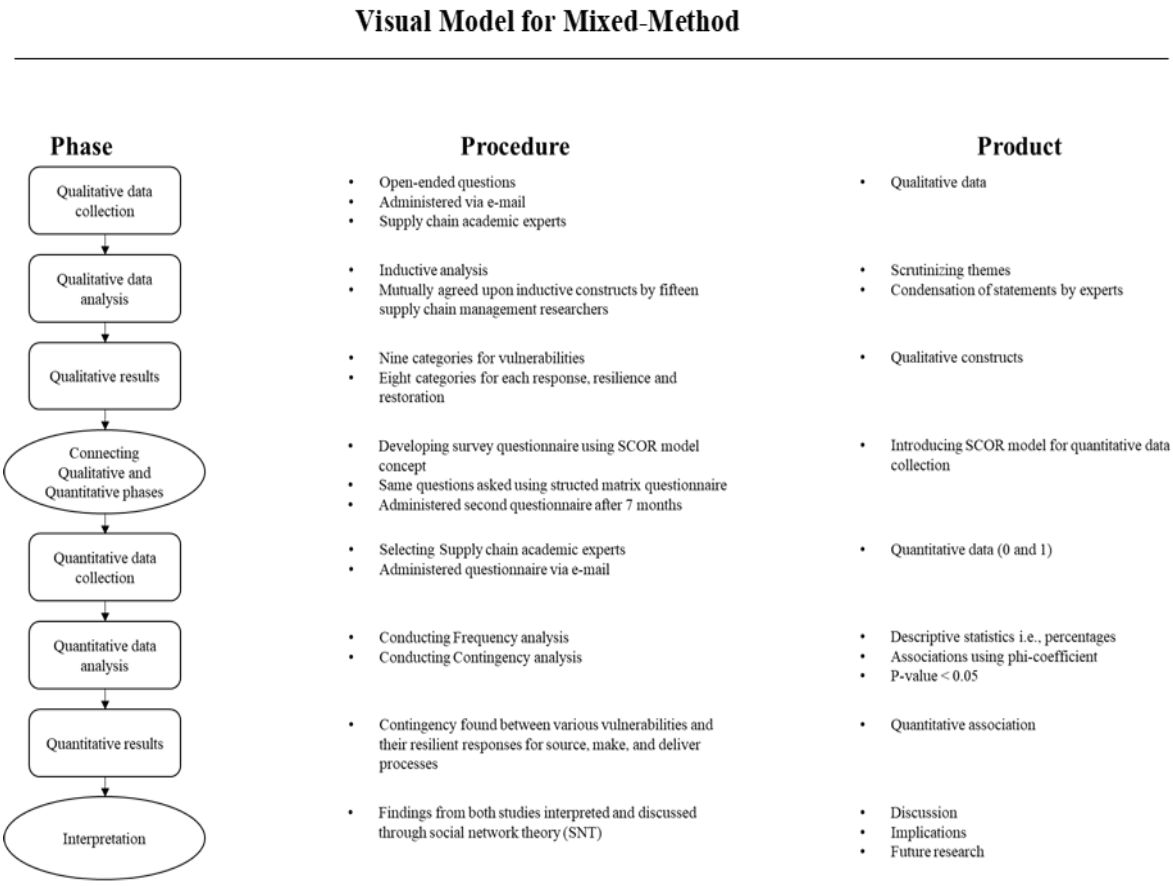

Figure 6.1 Study design based on Creswell and Clark, 2007

The MMD phenomenon involves a Qualitative→quantitative design that is conducted sequentially (Morse and Niehaus, 2009). More weight is given to the qualitative design because it involves exploring underlying factors that satisfy our main research question. Furthermore, an additional concept (i.e. the SCOR model) for the quantitative study was also based on qualitative variables identified in phase one of the study.

3.1. Qualitative study

For the qualitative study, an exploratory case study design was followed (Yin, 2017). An exploratory case study design is often selected when one's main research questions are "who," "what," "where," "how," and "why" questions, one's focus of study is a contemporary (as opposed to an entirely historical) phenomenon—a "case" and one wants to identify specific practices that were to be covered by the later study (Yin, 2017). According to Yin (2017), an exploratory case study involves debating the value of further investigating various hypotheses or propositions. Since this study aimed at the contemporary pandemic situation faced by developing countries, where the

specific research questions aim to uncover the specific factors or capabilities to be covered by the later study, an exploratory case study was an appropriate choice for the first method of the MMD. Based on the main research question, developing countries were considered to be a single "case" where the people having both theoretical and practical knowledge for making SCs resilient were the unit of analysis, such as SCM academic experts with industrial experience. For this purpose, an open-ended questionnaire was devised to identify the underlying resilience factors by asking academic experts in the field (Saunders et al. 2009). The respondents were from three emerging and neighbouring countries: Pakistan, India and Iran. These three countries, together, cover a huge part of the Asian region and face similar financial and social challenges; Iran is facing additional sanctions-related challenges. Therefore, making them a part of the study would proffer solutions that could not only help make SCs resilient against this pandemic but also help them in the long run to overcome some of the ingrained SC risks.

This exploratory method aimed to gather first-hand insights from academics working in SC management. The questionnaire was devised using an online platform i.e. SoSci Survey (Saunders et al. 2009). The link to this questionnaire was then administered to SC academic experts via e-mail from June 2020 through August 2020. A total of 24 participants replied to the first questionnaire (Table 1). The problem statement explicitly aimed to explore the underlying factors that can and are helping practitioners overcome vulnerabilities amid the pandemic. Experts were also asked about the role of social capital in this context because the role of social capital is often highlighted in both resilience and emerging economies literature (Lang et al. 2021; Polyviou et al. 2019). Therefore, the open-ended questionnaire comprises questions such as: What are the vulnerabilities, what are the risk response measures, how are companies building resilience for future risk mitigation, how do they restore operational activities and what role does social capital play in this regard? The qualitative data gathered from these questions were further inductively analysed. The data comprised several quotes from the experts, which were condensed based on definitions from the literature (Saunders et al. 2009). The condensed themes are presented in Table A1 (Appendix).

3.2. Quantitative study

For the quantitative study, a survey design was followed. We observed from the qualitative analysis that some of the respondents were pointing towards three major processes of the SC: source, make and deliver. Since the link between these major SC processes has been distorted by the pandemic (Butt, 2021) which created performance challenges, heterogeneity is expected in

vulnerabilities faced at different SC nodes and in the responses to these vulnerabilities. Nevertheless, this emergent taxonomy from the qualitative analysis would also generate understanding covering operational processes and essential metrics/categories within each process. Previous literature defines SCOR model as a performance measurement instrument or a reference model comprising multiple metrics (Aman and Seuring, 2021a). The use of model in the empirical studies either builds on the existing metrics or incorporate more metrics specific to industry (Persson, 2011), but it has hardly been used as a map for monitoring resilience which makes it even more important to consider in this study. It will also inform the policy makers about the metrics which are relevant to survive amid a disruptive event. Therefore, an SCOR model (Huan et al. 2004) was added in the quantitative questionnaire.

As mentioned before, the quantitative questionnaire followed a matrix in which respondents were asked to tick the boxes following an SCOR model concept. The respondents had to choose the three most important constructs for each source, make and deliver processes. A link (SoSci Survey) to the questionnaire was administered to SC academic experts via e-mails from January 2021 through March 2021. A total of 41 participants replied to the second questionnaire (Table 1).

Table 6.1 Total responses from both qualitative and quantitative studies

	Qualitative phase (sample size)	Quantitative phase (sample size)
Total valid responses	24	41
Total experts approached	89	150
Time duration of data collection	June 2020-August 2020	January 2021-March 2021

For the quantitative study, we approached all respondents from the first phase of the study, along with more academics working in the SC management domain. The choice of academic experts was made for both studies for three reasons. First, our research questions aim to uncover the vulnerabilities and resilient capabilities that SCs are currently facing and incorporating employees of a single organisation would have resulted in solutions specific to an organisation rather than an SC. Second, the academics are scrutinising the situation more closely to find opportunities that could contribute to their own research; this may also include indirect information from industrial experts. Third, SC academic experts with extensive industrial experience (Table 2) can contribute to both theoretical and practical insights; therefore they can offer solutions beyond the specific point in time, i.e. future pathways.

Table 6.2 Academic and industrial distribution of experts

Years of experience (x)	Number of respondents in academia	Number of respondents in industry	Minimum - Maximum year(s) academia	Minimum - Maximum year(s) industry	Percentage of respondents in academia	Percentage of respondents in industry	Industry
x ≥ 20	3	0	21-43	-	7.3%	-	-
10 < x < 20	16	8	11-19	11-19	39.02%	19.51%	Oil and Gas, Finance, Automotive
5 < x ≤ 10	9	9	7-10	6-8	21.95%	21.95%	Food, Textile, FMCG
x ≤ 5	10	21	1-5	1-5	24.39%	51.22%	Manufacturing, Textile
Answered	38	39			**92.68%**	**95.12%**	
Not answered	3	2			**7.3%**	**4.9%**	
Total	41	41			100%	100%	

The data from academics for the second phase of the study ensure that consistency has been achieved in the responses within two studies. As shown in Table 2, it is evident that 95% of the respondents had at least one year of industrial experience also. Therefore, they were capable of offering solutions from both theoretical and practical perspectives. Moreover, the complexity involved in sequentially reaching the respondents over time made the study follow a longitudinal design. Since the situation in the pandemic was continuously changing during that time, the findings from this mixed-method approach are highly reliable.

The data gathered from the second phase of the study was in 0s and 1s, where 0 means a category is not selected and 1 indicates a category is selected. The data were then analysed by conducting a frequency analysis and a contingency analysis employing Fisher's exact test in SPSS (Table A2, Appendix). The frequency analysis shows how many times a certain category was selected by the respondents. A contingency analysis is a non-parametric statistical analysis technique that is applied to dichotomous data sets (i.e. 0s and 1s) (Fleiss et al. 2013). It shows the association between two categories/constructs indicated by a value of phi-coefficient (w). To be considered relevant, the value of the phi coefficient should be greater than 0.3 and is significant at a p-value of less than 0.05 (Fleiss et al. 2013). Therefore, contingency and frequency analysis were deemed appropriate for the second phase of the study, showing which factors were important for our respected respondents and how they were interlinked.

4. Findings

The findings from both qualitative and quantitative phases are presented in sections a) and b), respectively. These sections include descriptive and overarching understanding of the gathered data; however, how the major findings from both phases are interpreted is presented in the subsequent section c).

4.1. Findings from qualitative data

The data gathered from qualitative phase identified numerous vulnerabilities and corresponding solutions; therefore, we analysed the total number of statements apart from the number of responses. There were 77 statements for the first question, which were further condensed into constructs (Table 3).

Table 6.3 Vulnerabilities

No.	Constructs condensed from statements	Number of times a construct appeared in the statements
1.	SC disruption	14
2.	Logistics	14
3.	SC volatility	12
4.	Finance	11
5.	Workforce/HRM	9
6.	Supply network	5
7.	Government	5
8.	SC disturbance	3
9.	Redundancy	4
		77

The two most frequent categories were “SC disruption” (14)—which comprises supply disruptions—and demand (customer) disruptions. The other most frequent category was “Logistics” (14), which encompasses the issue of “Connectivity” (13) that affects firms and their SCs. “SC volatility” (12) was the third most frequently mentioned category. Other vulnerabilities were identified as “Finance” (11) and “Workforce/Human resource management (HRM)” (9). SC disruption and logistic challenges were evident for emerging countries because of the distortion of the connections within regional boundaries. Here, SC disruption pointed towards the long-term disruption of SCs (Pfohl et al. 2010) and logistics referred to lockdown-related connectivity issues. SC volatility refers to a situation where the majority of SCs are on the verge of losing their

operational activities due to changes in cost, raw material or currency exchange rate (Christopher and Holweg, 2011). Since the majority of blue-collar workers and small- and medium-scale businesses operate in developing regions of the world, risks of SC disruption, logistical challenges and volatility are exacerbating the situation for them. Therefore, solutions specifically related to these vulnerabilities are needed.

Respondents offered a variety of solutions for current vulnerabilities, which were analysed and then condensed as per Table 4.

Table 6.4 Number of times a construct is mentioned in the statements

No.	Construct	Risk response measures	Resilience to mitigate future risks	Restoring operations
1.	Agility	**29**	15	15
2.	Finance	13	6	1
3.	Workforce/HRM	9	8	**19**
4.	Digitisation	6	7	3
5.	Risk management culture and knowledge	5	10	9
6.	Government support	3	0	6
7.	Supply network	2	**17**	8
8.	Logistics	1	3	0
		68	66	61

The three most frequently mentioned categories were “Agility”, “Supply network” and “Workforce/HRM”, in their respective questions. Most statements under “Agility” either pointed towards flexibility (6) or were closely related to flexibility (3). Further, it also included statements of “redundancy” (8) and “diversification” (7). “Supply network” occurred mainly in connection with supply or resource alternatives and also a strategic reorientation regarding supply (5). Moreover, the need for local suppliers and resources was mentioned frequently (4), as well as the configurations and adjustments of the SC (4). “Collaboration” was also mentioned under this category (3). “Workforce/HRM” comprised mainly typical “HRM”- related issues regarding the workforce and was also due to health-related issues that were condensed under “Workplace safety/hygiene” (9). Therefore, these three categories are essential for the current and future resilience of SCs.

Furthermore, “Finance” and “Risk management culture and knowledge” were also important considerations for current risk response measures and future risk mitigation, respectively. In “Finance”, “Cost management” was found eight times. Regarding financial management-related statements, most findings mentioned increasing the price of goods or services (4). “Risk management culture and knowledge” contained mainly “risk management” (3), “Contingency planning”, anticipation and continuity planning (3).

SC agility, human resource management and financial management have emerged as the three most prominent categories in current efforts to measure risk response and restore activities. Agility is found for emerging economies because a relative shift in the operational activities of textile companies to designing the masks and other protection gears has been observed. SC agility can be achieved in such a situation if the information regarding these responsiveness measures is shared in a timely and accurate manner between upstream and downstream SC actors. Similarly, managing finances either through government support programmes, such as self-reliant India, and programmes to ease lockdowns, such as the “smart” lockdown in Pakistan imposed to combat Covid-19 and to provide financial relief to blue-collar workers and small-scale businesses, or increasing the cost of some products and services can help to curb current financial deficits. This can also help in the timely restoration of operational activities and minimise the threat of bankruptcy. Besides, workforce and human resources need to be reorganised by giving them necessary hygiene and safety training and imposing fines for negligence. Reorganising human resources for safety and hygiene purposes restrains the spread of the disease, thereby increasing the chances of restoring the operations faster. These categories together form three major resource reconfigurations—information, financial and human—and can therefore be defined as “the ability of a firm to reconfigure, realign and reorganise their resources in response to changes in the firm’s external environment” (Ambulkar et al. 2015, p. 113).

Supply network structure and establishing a risk management culture are two crucial factors for building resilience against similar future events. Establishing risk management culture would help foster the sharing of information about past similar events between SC actors, thereby making future SC more resilient. Moreover, the network structures involve a variety of links between nodes (i.e. SC actors) and are one of the prominent aspects of social capital (i.e. structural social capital; Polyviou et al. 2019; Ansari et al. 2012). Enhancing the network structure by strengthening the already existing links, as well as developing new and alternative links between nodes, would make SC resilient against future disruptive events.

Finally, in response to the role of social capital, 49 statements were collected (Table 5):

Table 6.5 What role does a firm's social capital play in this context?

No	Constructs condensed from statements	Number of times a construct appeared in the statements
1.	Relational capital	20
2.	Cognitive capital	9
3.	Ease adaptability-modifying operations, alternate technology	7
4.	Ease customer relationship management	4
5.	Structural capital	4
6.	Government	3
7.	Finance	2
		49

The category "Relational capital" was mentioned most frequently. Similarly, "Community support" was identified frequently (6). In addition to employees, the relationships in the SC were identified in this category (5). In addition to trust, a better understanding of each other's problems to improve goodwill among SC members and to ease stress was found. The second most frequent category is "Cognitive capital". "Cognitive capital" mainly occurred through "employee support" (6). Under same construct, "Commitment" was mentioned six times, which is the employee's willingness to "give energy and loyalty to the organisation" (Kanter, 1968, p. 499). From these responses, it was observed that social capital eases information sharing, thereby making adaptability much easier for the firms. It also facilitates the demand of information from customers to upper-tier SC actors. Therefore, social capital plays a crucial role in making firms resilient.

In sum, the findings suggest that the current responses required for the timely restoration of activities mainly comprised the reconfiguration of resources such as human, financial, information and material. However, future mitigation of similar disruptions involves building network structures, where cognitive and relational social capital can play a central role.

4.2. Findings from quantitative data

Frequency analysis

The findings from the above study helped eliminate the constructs that were mentioned only a few times. The qualitative process left us with a total of nine categories for vulnerabilities and eight categories each for response measure, resilience and restoration (Table 6). Table 6 also shows the aggregated frequency analysis using the SCOR model concept (i.e. source, make, deliver; Huan et al. 2004). The table includes the categories that have frequencies greater than 50% for a specific process.

Table 6.6 Frequently selected categories by the respondents (i.e., greater than 50%)

	VULNERABILITIES			
01	Challenges in supply network management			-
02	SC disruption(s)			Make
03	SC disturbance(s)			-
04	SC volatility			Make
05	Logistical challenges			-
06	Challenges in workforce/HRM and hygiene management			Source, Deliver
07	Challenges in digitisation			-
08	Financial challenges			Source, Deliver
09	Governmental regulations			-
		RESPONSE MEASURES	**RESILIENCE**	**RESTORATION**
01	Strengthening supply network	-	-	Make
02	Increasing SC agility	-	-	Deliver
03	Improving logistics performance	Source	-	-
04	Improving HRM and hygiene management	Source, Deliver	Source	Source, Deliver
05	Enhancing digitisation	-	-	-
06	Improving financial management	Source, Deliver	Deliver	-
07	Receiving government support	-	-	-
08	Establishing risk management culture, knowledge and system	-	Deliver	Deliver

In the first question, the most frequently selected category, with 66% (S) and 78% (D), was "Challenges in workforce/HRM and hygiene management". Similarly, SC disruption (51%) was characterised as having a long-term impact on the SC (Pfohl et al. 2010). The other most frequently selected categories included "SC volatility in make" (56%) and "Finance in source (54%) and deliver (63%)". The analysis concerning the SCOR model showed that the two categories for each of the "Source", "Make" and "Deliver" processes were frequently selected (Table 6).

In the second question, the categories "Improving HRM and hygiene management" in "Source" and "Deliver" and "Finance" in "Source" represented 76%, 66% and 66%, respectively. Therefore,

these were the most frequently selected categories in their respective processes. Similarly, "Finance" in "Deliver" represented 63% of the participant selection and "Improving logistics performance" in "Source" represented 56% of the selection.

In the third question, which asked about building SC resilience, "Improving HRM and hygiene management" in "Source", "Finance" in "Deliver", and "Establishing a risk management culture, knowledge and system" in "Deliver" represented 76%, 59% and 56% respectively. Therefore, these were the most frequently selected categories in their respective processes.

In the fourth question, "Improving HRM and hygiene management" in "Deliver" and "Establishing risk management culture, knowledge and system" in "Deliver" fetched the highest percentage values of 66% and 61%, respectively. Other categories such as "Strengthening supply network" in "Make", "Agility" in "Deliver" and "Improving HRM and hygiene management" in "Deliver" represented 51%, 51% and 59% of the share, respectively.

Contingency analysis

The contingency analysis was based on the responses from 41 experts from three base of pyramid (BoP) regions: Pakistan, India and Iran. A contingency analysis shows the association between two categories (i.e. which two categories were selected simultaneously by the respondents). Since one of the core questions of the study was how firms can manage the vulnerabilities that this pandemic brings, the contingency was calculated between vulnerabilities (items of question one only) and their responses (including items from all three questions).

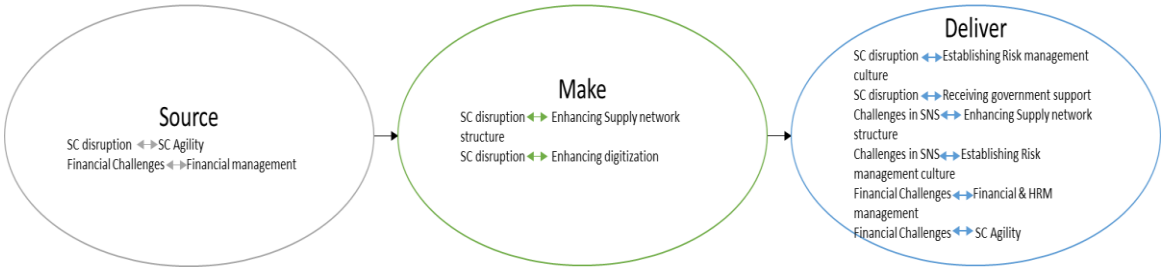

Figure 6.2 Significant contingency observed on the data from the quantitative study (Table 8, Appendix), N = 41, p-value < 0.05.

For all three processes, it was observed that SC disruption is a major vulnerability for emerging economies, whereas solutions offered to combat it lie in the reconfiguration of resources, including financial, technological, human, information and material (Figure 2). In addition to the financial, technological and human resources, establishing a risk management culture and knowledge system by continuously sharing information creates a cycle of keeping track of operational activities and

overcoming the challenges that long-term disruptive events can bring (Yu et al. 2019). Similarly, adaptation of the material resource to meet the changing demand during disruption also helps combat the effects of long-term disruption (Adobor, 2020; Giannoccaro and Iftikhar, 2020). Moreover, supply network structure plays an integral part in making SCs resilient against disruption (Ali and Gurd, 2020; Ivanov and Dolgui, 2020). Other vulnerabilities highlight the financial challenges that are evident on the "source" and "deliver" sides because of the breakdown between the demand and supply. The firms in these countries seek government support either as relief packages or to ease lockdowns to overcome financial challenges. Therefore, monitoring these factors along the chain would help trigger the vulnerabilities and timely overcome long term disruption.

4.3. Interpreting qualitative and quantitative results

From the results of two studies together, we found three important considerations in making an SC resilient against any disruption: network structures, resource reconfiguration and social capital. SNT supports the argument that firms with better supply network structures are better positioned to become more resilient against disruption (Figure 3). Not only this, but prior research has also highlighted the role of these relationships together with collaboration efforts and shown their impact on sustainability-related dimensions (Mathiyazhagan et al. 2020; Awan et al. 2020). Nevertheless, the theory of social networks helps explain the benefits derived by a firm viewed as embedded within a larger network of structurally interdependent partners. This lens emphasises that the benefits accrued from access to the knowledge, resources and information available within a network of relationships can lead to an organisational advantage (Granovetter, 1992). Therefore, firms with better supply network structures are more likely to gain knowledge, resources and information than other firms. Not only this, but they are also in a better position to reconfigure the resources of the organisation, thereby making it more resilient against disruption (Feizabadi et al. 2021; Ivanov, 2021; Mathiyazhagan et al. 2020; Ambulkar et al. 2015).

P1. Supply network structure is negatively related to SC disruption (i.e. a strong supply network structure leads to less SC disruption).

P2. Resource reconfiguration plays a mediating role between the supply network structure and SC disruption.

Bellamy et al. (2014) categorised network structures as network accessibility and interconnectedness. Supply network accessibility refers to the ease and effectiveness with which a firm can access information and knowledge from other members in its supply network, including

indirect access to members with whom they do not share a direct relationship. In addition, it also reflects the speed of information access. In other words, high (low) levels of supply network accessibility allow a firm to traverse fewer (more) steps or connecting points to reach supply network members—for example, lower tier suppliers— thereby gathering heterogeneous information from the connecting points. This is specifically important in risk response generation because it can provide new solutions to novel problems. However, the unconnected contacts increase opportunistic behaviour (i.e. creating dissatisfaction with the supplier), but collective goals/narratives stifle opportunistic behaviour and improve coordination for implementation of resource reconfiguration (Villena et al. 2011). From an SNT perspective, this is known as cognitive social capital and it refers to those links that help generate shared language and vocabulary and the sharing of collective narratives (Nahapiet and Ghoshal, 1998; Polyviou et al. 2019). Therefore, shared language and vocabulary facilitate the exchange of heterogeneous information and collective goals and narratives overcome opportunistic behaviours between diverse contacts, thereby making resource reconfiguration easier.

P3. The presence of cognitive social capital strengthens the relationship between network accessibility and resource reconfiguration.

Supply network interconnectedness refers to the degree to which the supply network partners of a focal firm are connected to each other and thus share direct links amongst themselves (Bellamy et al. 2014). Supply networks are considered densely interconnected when there are many shared linkages amongst the supply network partners of a focal firm (Son et al. 2021). This helps generate homogeneous information (i.e. information based on past similar experiences). Moreover, sharing this homogeneous information thoroughly and promptly, either through close interactions or because of normative pressure (Granovetter, 1992; Kale et al. 2000; Polyviou et al. 2019), can make the implementation of response measures much easier.

P4. The presence of relational social capital strengthens the relationship between network interconnectedness and resource reconfiguration.

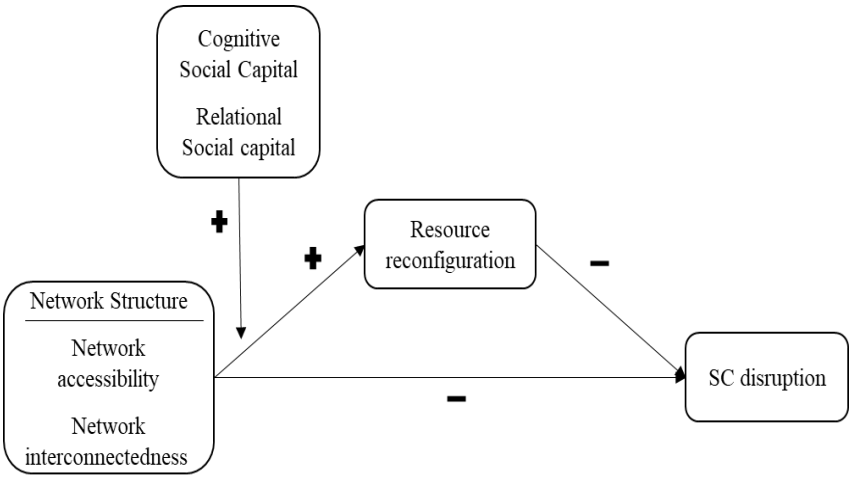

Figure 6.3 Proposed framework against disruption.

5. Discussion

The study aimed not only to explore current efforts in dealing with the pandemic but also to proffer a generalised framework that could help make firms resilient against any similar situation. The mixed-method study in this paper investigated the current developments in emerging countries, including Iran, India and Pakistan, against the pandemic. Moreover, these countries offer a perfect platform for exploring the concept of resilience because of their existing turmoil.

To prevent the spread of the virus within regions, countries' borders were closed, and additional lockdowns were necessary to protect the people. This, in turn, had a significant impact on the supply, manufacturing and demand sides. While other natural disruptive events, such as earthquakes or volcanic eruptions, happen quite frequently and are well documented, the last global influenza pandemic was the Spanish flu, which had a significantly weaker impact on the stock market (United Nations, 2020; Baker et al. 2020). The impact of the Covid-19 pandemic can be considered a long-term disruptive event (Ivanov, 2020; Fernandes, 2020). Therefore, a solution with a long-term impact is required.

Recently, researchers have also highlighted the importance of designing supply networks that can be resilient to a variety of disruptions (Ali and Gurd, 2020; Ivanov and Dolgui, 2020; Li et al. 2020; Wong et al. 2020). However, how these networks should be designed to ensure robustness is somewhat contested in the literature. Our findings contribute to this regard, as we found that "Enhancing supply network structure" is a viable solution to SC disruption and that relational and cognitive social capital plays a vital role therein. We argue this in light of SNT (Bellamy et al.

2014), hence justifying its importance from a theoretical perspective as well. Using a SCOR model, which serves as a map and guideline for finding factors specific to SC operational processes (Persson, 2011), suggests that social capital is a prominent capability or factor of a system that facilitates material, information and financial flows. This capability emerged as an important resilience factor in "Make" and "Deliver" processes only, highlighting the need for strong structural designs for manufacturing and delivery firms. These structural designs then facilitate information sharing (for example, forecasting customer demands), thereby easing decision making about product characteristics such as make-to-order, make-to-stock or make-to-engineer (Persson, 2011). Specifically, in the prevailing situation, agility can be built and financial resources can be reconfigured with an accurate forecast of consumer demand and timely sharing of information from delivery to manufacturing to sourcing firms or vice versa. Nevertheless, practitioners and policymakers can use these metrics into their performance measurement systems and continuously monitoring these metrics would help in detecting early diversions from the targets (Aman and Seuring, 2021a) and can control disruption.

The reconfiguration of human and technological resources plays a central role in overcoming SC disruption arising from the pandemic. Prior research has also highlighted the importance of collaboration for increased social performance, such as health and safety (Awan et al. 2018). The literature also argues that the relational ties in these collaborative efforts could help create and manage human capital (Zhu and Lai, 2019). Since the health and safety of employees is one of the major concerns of firms in developing regions, realigning or reorganising human resources while incorporating digital transformation could help combat SC disruption and restore operational activities. Similarly, close relational ties facilitate knowledge transfer between nodes, making these reconfigurations of resources easier between partners.

5.1. Practical implications

The pandemic has changed the usual ways of doing business, including the use of resources that need new ways of being handled and reconfigured. However, we propose that firms that are positioned to better implement these new ways are more likely to become resilient. The strong structural networks can help organisations better reconfigure their resources, thereby making their firms more resilient against disruption. Furthermore, practitioners and policy makers can incorporate the SCOR metrics/factors outlined in this study into their performance measurement systems and ensure their continuous monitoring for firm's resilience.

5.2. Limitations and future research

The respondents mainly comprise academic experts from three emerging economies, which make the findings interesting, yet lack an industrial expert's perspective. Nevertheless, the propositions can be tested in industrial settings to see whether the results are limited to a specific industry or are rather generalised.

Form a theoretical perspective, other theoretical lenses could have been used to make propositions for example "institutional theory". However, the network structure, as well as the cognitive and relational social capital, resonates well with the SNT perspective. The network structure has been characterised in a variety of ways in the past and is not necessarily limited to the two dimensions of interconnectedness and accessibility (Son et al. 2021; Kim et al. 2011); however, the most prominent of them are found to be these two characterisations (Carnabuci and Di_oszegi, 2015; Bellamy et al. 2014). Therefore, the future researchers can use these two, along with other dimensions of network structures, in their analysis.

The SCOR model is used as a reference model only to find underlying factors for SC resilience specific to the SC processes of source, make and deliver. Therefore, how the model compares with network theory is beyond the scope of the current study. The comparison could fetch interesting insights for both academics and practitioners alike and thereby serve as a potential agenda for future research.

6. Conclusion

From the extensive mixed-method findings and the SNT arguments, we found that the firms that are better structured in their network are more likely to become resilient. These structural networks can help organisations reconfigure their resources better, thereby making their firms more resilient in restoring their operational activities. Additionally, social capital eases the implementation of resource reconfigurations through cognitive and relational dimensions. The mixed-method findings better inform these practices, which can help firms become resilient while operating in BoP countries. The implications for the practitioners of BoP countries are evident. If considered promptly, it can help restore the current operational activities and be beneficial in the long run. Lastly, the future research can find underlying factors from other developing as well as developed countries and compare them in light of the SCOR model.

7. General discussion and conclusion

While Chapters 2 to 6 include individual discussion sections, this chapter reflects on the dissertation's core contributions, limitations, and research implications. This reflection is guided by the topics of intersection between risk and performance and related contribution to the BoP context under the broad umbrella of (S)SCM. Further subsections elaborate the theoretical and practical implications of the respective debate. Lastly, this chapter presents the dissertation's limitations, research directions, and concluding remarks.

7.1. Contributions to the SCRM and SCPM discourse

With the aim of exploring SC performance and SC risk in the BoP-SCs context, this thesis offers several contributions. Starting with the PM in risk management, the thesis offers a clear conceptualisation of the performance building on the SSCPM concept and further integrates the PM in the risk management process. This initial conceptualisation in Chapter 2 sets the foundation of the entire thesis, further elaborating on the respective concepts in Chapters 3 and 4, particularly from a BoP context. Lastly, an empirical demonstration of SCPM and SCRes is presented in Chapters 5 and 6.

As mentioned in Chapter 2, contributions to the supply chain risk and performance management domains are twofold, whereas in literature these explanations were previously fragmented. Early literature tries to identify the causality between the two by implying that performance is a driver of risk (Bowman, 1982) and discusses the influence of performance on risk and vice versa (Miller & Bromiley, 1990). This implies that an interplay between performance and risk exists. However, a clear conceptualisation has been underdeveloped to date. The chapter also distinguishes between the short- and long-term performance measures and clearly conceptualises the constructs based on existing literature (Figge et al., 2002). Therefore, this thesis offers consolidated argumentations and explores the concepts using relevant literature.

Similarly, Chapter 3 explicitly explores the SSCPM in the BoP context. This chapter provides a definition of SSCPM by refining the existing PM definition and including the sustainability aspect. The aim of conducting this study was to determine how SSCPM constructs are considered in the BoP literature. The analysis showed that BoP literature discusses several PM tools and related concepts, systems, instruments, and indicators and proffers "innovation" as a KPI in the BoP regions. Therefore, Chapters 2 and 3 set the foundation for Chapter 4.

Chapter 4 specifically explores the prevailing risk management strategies and prudently links them to the PIs by reviewing this conceptualisation at the BoP-SCM intersection, thereby offering a visual demonstration of the conceptualisation presented in Chapter 2. However, no direct link between the risk management strategies and PM tools, instruments, concepts, and systems has been found, leaving a gap for future research. Before exploring the interplay, the SC literature only considered the risk management strategies as a standard design, which should be applied to reduce the risk levels. Nevertheless, this neglected the mere notion of additional cost, resources, and relative performance measures that can contribute to the system's complexity. For example, Yang and Yang (2010) examine two commonly discussed supply chain risk mitigation strategies, such as redundancy and flexibility, and argue that reducing the tight coupling to protect a system against disruptions may involve adding slack or buffers. They also mention that "while recognising the added costs associated with providing additional capacity and resources, the SCM literature ignores the potential resultant increase in the complexity…. Excess resources also provide false security into the safety of a system, and small problems or failures thus become less visible" (Yang and Yang, 2010, p. 9). Similarly, the SCRM literature also acknowledges that flexibility comes at a cost (Manuj and Mentzer, 2008). Therefore, implementing risk management strategies without considering performance measures will likely exacerbate the system's complexity and expose SCs to more risks. Chapter 4 shows the influence of risk on performance, as discussed in Chapter 2, thereby contributing to this debate.

Chapter 4 also argues that disruption is the least studied risk in the BoP context. Together with the pandemic situation, disruptions further demanded SC scholarly work. Since disruption constitutes a key element of SCRes (Pettit, 2019), diverting to this line of argumentation was beneficial for addressing the gap in BoP and SCRes literature. Thus, Chapters 5 and 6 contribute to this debate. Furthermore, the use of the PM instrument (i.e., the SCOR model) was applied to merge with the overall logic of the dissertation. The contribution from Chapter 5 includes taking a global perspective on the pandemic situation and shedding light on different resilience factors being applied in specific countries/regions. This leads to a specific demonstration of the heterogeneity among the regions in their responses to the situation. The Covid-19 pandemic exposed the organisations' structural flaws. As a result, organisations' recovery primarily depends on their ability to quickly re-mobilise their complex multi-country SCs. It also depends on how best they can map and manage the risks (Belhadi et al. 2021). Chapter 5 maps the resilience factors and associated risks from various regions, which vary in their geographical dispersion and institutional

characteristics. Thus, this study offers a consolidated view previously sought by the researchers (for example, Belhadi et al. 2021).

Chapter 6 further extends the understanding of the interlink between performance and risk-taking developing regions as the contextual environment. The study contributes to the PM and risk management literature at the nexus of BoP-SCs in two ways. First, it specifically presents a model to combat disruptions by taking various dimensions of social capital as both the antecedent and moderators and resource reconfiguration as a mediator. Disruption is linked to the risk management literature (i.e., Chapter 4), whereas social capital and resources are part of PM systems (Chapters 2, 3, and 4). The study also uses a SCOR model to find factors specific to the SC processes and then employs a theoretical lens to justify the links found. Second, the findings contribute to the debate on the influence of performance on risk, as discussed in Chapter 2. Chapter 2 highlights that while there is sufficient literature discussing the influence of risk on performance, less attention has been given to the influence of performance on risk. Hence, Chapter 6 contributes to the latter debate.

7.2. Contribution to the BoP discourse

As mentioned in section 1.1., globalisation has brought developing regions into perspective. With the changing paradigms of today's world, measuring the performance of SC processes and actors in these regions has become more important for various reasons. First, increasing focus on sustainability measures puts pressure on the companies to ensure the sustainability of the entire SC. For the upstream performance in the developing regions, related indicators can curb the sustainability risks. For example, most developing regions are crucial parts of resource-based global supply chains (Silvestre, 2015), serving upstream on the SCs. Thus, it is essential to ensure the practices of these upstream SC actors conform to the mission of the company so as to avoid reputational losses, which increase the likelihood of financial risks. Second, offshoring poses a threat of opportunistic behavior, which is difficult to determine by the SC actors. Having PMs based on the indicators such as "quality" and "trust" can ensure the integrity of the first- and second-tier suppliers, thereby reducing the probability of risk occurrence. These also are important considerations when organisations devise plans for BoP regions.

Considering the "consumer-oriented" and "inclusive business-practices" arguments, it is evident that the measurement of "quality" and "social capital" play a crucial role in overcoming the risks associated with the two. The BoP literature comprises these two main themes, which suggested

exploring the BoP literature and further guided the choice of conducting literature reviews. This addresses the gap of coherent study as highlighted by Tate et al. (2019). Indeed, there are myriad ways this gap could have been addressed, but this dissertation contributes to the understanding that coherently links the two themes in BoP-SCM literature, specifically taking the risk and performance constructs.

Furthermore, the highly uncertain environment of these markets stresses the need for short-term PMs, which should be well aligned with the firms' strategic vision. Chapters 3, 4, and 6 contribute to this body of knowledge. They offer various PMs specifically to the developing region and align them with the risks that prevail in these environments. Therefore, it is suggested that the incorporation of PIs for risk management is crucial, which is also a major practical implication that emerged from this dissertation.

Chapter 6 further extends the understanding of the pandemic situation with special consideration to the developing regions. The study contributes not only to the PM and RM literature at the intersection of BoP-SCs but also to the SNT by taking the social capital perspective. Three social capital constructs (i.e., structural, relational, and cognitive capital) were incorporated and presented in the model for combating disruption risk through resource reconfiguration. This amalgamation of three concepts entails that having the best structural characteristics cannot sufficiently address the disruption risk, which was also a precondition for the sought theoretical comprehension. Nevertheless, the relational and cognitive social capital improves the structural ties and allows successful reconfiguration of resources, which can circumvent the disruption risk. Conclusively, the idea addresses several recent calls from the research community to apply the existing theoretical lens to the pandemic situation to enhance theoretical and practical understandings.

Moreover, the construct "resource reconfiguration", specifically focusing on three main resources, was added to improve the theoretical underpinning of SNT. These three resources are "technological", "financial", and "human" resources. The choice of SNT as a theoretical lens was purely dictated by the findings of the two phases of Chapter 6. At the same time, the use of social capital construct was guided by the findings of Chapters 3 and 4 as it emerged as one of the possible solutions to outmaneuver the risks that define the mere environment of these developing/BoP markets.

Lastly, the methodologies adopted in these chapters also contribute to the respective domain. Especially the Delphi method, which even though includes various regions, the consideration of Africa and Asia together shows its inclination toward developing regions. Arguably, the methodological dispersion of the BoP literature (Chapters 3 and 4), a Delphi study was not conducted in this setting thus far. Therefore, this dissertation partially contributes to addressing this gap.

7.3. Limitations and future directions

There are some limitations and directions for discussing and developing the topic, especially from scientific, theoretical, and/or research investigation perspectives. First, what PM tools, concepts, systems, instruments, and indicators are linked to risk and risk management strategy? This highly depends on the company's values, mission, and vision statement. While Chapter 4 presents a literature review and offers a good starting point for the underlying debate by offering an overarching linkage between the constructs, the specific linkage is yet to be sought. For example, linking the two better in such a context requires the company's managers to consider both the company's process and strategic performance objectives. Consequent strategies and accurately linking them with process level PIs will ensure that the maximum risk can be avoided.

Moreover, these PIs for risk management can further be devised for internal, upstream, downstream, and reverse logistic activities as well as actors using the PM tools, systems, and instruments to ensure SC level effectivity. Chapters 5 and 6 present a visual demonstration of the idea. Nevertheless, the use of the SCOR model is limited to three processes: source, make, and deliver. Therefore, this dissertation suggests future research to identify factors from the "return" process. Future studies can use the underlying argumentation of the dissertation in circular SCs because it deals with the "return" process of the SCOR model, which can further enhance the understanding of the conceptual underpinning.

Further, the PIs vary from company to company and should be the focus of the focal firms. For example, the PIs for food supply chains could be different from the automotive and apparel SCs. This dissertation recommends that some of the investigated PIs could be applied to all these SCs. Yet, it should be noted that the proposed list of indicators is not completely exhaustive. Therefore, future research could study specific indicators based on the companies' objectives and strategies.

The dissertation is also limited in explaining the difference between constructs, for example, between PIs and capabilities or factors. Most of the terms that are used interchangeably with

capabilities are presented in Chapter 6, beyond this the discussion on the differentiation between other terminologies lays outside the scope of this thesis. Therefore, a conceptual paper analysing similarities and differences between the terminologies used in SCPM and SCRM literature could enrich the academic community's understanding.

Furthermore, the use of SNT with social capital allowed to explore some of the behavioral aspects (opportunistic behaviors) which expose the SCs of developing regions to disruption risk. The proposed model in Chapter 6 is based on a mixed method study that can further enhance existing knowledge by testing the propositions in industrial settings, for example, conducting a confirmatory study using a survey design. Besides, researchers can use a case study research approach to find what other SNT dimensions can be linked to the other risk types, such as capacity and inventory risk. Similarly, what contingency factors do companies need to consider strengthen the social networks? Therefore, this initial debate on SNT sets the foundation to help the research community answer several remaining questions.

Lastly, the role of digitisation in risk and PM is yet to be explored. Chapters 5 and 6 shed light on the importance of digitisation but lack an in-depth understanding of how it can transform the coveted risk management practices. Digitisation can potentially ease the PM and help swiftly manage the associated risks with the evolution of digital components such as big data and the Internet of Things (IoT). Therefore, the elaboration of PM for risk management under this evolution holds several ideas for future studies.

7.4. Conclusion and reflection

After discussing the contributions, limitations, and research directions that can be drawn from this dissertation, these final remarks and reflections take a more comprehensive look at the context of the thesis and how the author addressed the ORQs.

This dissertation starts with a conceptualisation of SCPM in SCRM, followed by the literature reviews showing how PM and risk management have been considered in the BoP context. The underlying conceptual arguments have a broader horizon where the current state of BoP-SCM is relatively in its infancy. Considering both the consumer and inclusive business perspective, the risks in BoP-SCM suggest that collaboration and product design are the prominent strategies to circumvent the supply and demand risk, respectively. However, devising relative performance measures propagates the idea of the interplay between risk management and PM. The literature argues that BoP-SCM literature focuses mostly on the macro-economic level, where a link to the

tactical or operational level is missing (Khalid and Seuring, 2019). Therefore, this dissertation contributes to this domain and enhances existing knowledge by offering tactical level performance measures for operational efficiency, answering how measuring performance can help manage risk for the firms operating in the BoP environment. Consequently, this addresses the ORQs 1 and 2.

Lastly, empirical evidence proffers a visual demonstration of the idea of linking risk management and PM. It builds on the SCRes concept and extends the operational constructs to circumvent the disruption risk. The findings of these two studies further enrich the SCRes literature, which previously was not explored sufficiently in the global and local context with specific consideration to the pandemic. Hence, the overall dissertation promotes the notion of short-term PM for long-term effectivity.

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9. Appendix

9.1. Appendices of Chapter 3:

Table 9.1 English language (Peer-reviewed) Articles from Scientific journals

Journals	**Number of Articles**
Journal of Cleaner Production	11
International Journal of Physical Distribution & Logistics Management	6
Journal of Business Research	6
International Business Review	5
Journal of Business Logistics	5
Journal of Management Studies	4
Journal of Product Innovation Management	4
Technovation	4
Business Strategy and the Environment	5
Journal of Business Ethics	5
Business & Society	4
Organization	2
Renewable and Sustainable Energy Reviews	2
Technological Forecasting & Social Change	2
Business Ethics Quarterly	1
Business Horizons	1
Critical perspectives on international business	1
European Management Journal	1
Harvard Business Review	1
Industrial Marketing Management	1
International Journal of Production Economics	1
International Journal of Technology Management	1
International Marketing Review	1
Journal of Business & Industrial Marketing.	1
Journal of International Marketing	1
Journal of Operations Management	1
Journal of Public Policy & Marketing	1

Proceedings of the National Academy of Sciences (PNAS)	1
Production Planning & Control	2
South African Journal of Economic and Management Sciences	1
Strategic Entrepreneurship Journal	1
Supply Chain Management: An International Journal.	1
Sustainability	2
Sustainable Energy Technologies and Assessments	1
The European Journal of Development Research	1
World Development	1
The International Journal of Logistics Management.	1
Journal of Entrepreneurship in Emerging Economies	1

9.2. Appendices of Chapter 4:

Table 9.2 Risk phases adapted from Tummala & Schoenherr (2011).

Risk Phases	Description
Identification/measurement/assessment	Risk identification involves a comprehensive and structured determination of potential SC risks associated with the given problem, their consequences, magnitude of impact and likelihood of occurrence
Evaluation	Risk evaluation involves the sub-steps of risk ranking and risk acceptance. These two sub-steps are practical particularly when objective probability assessment is difficult or sufficient data are not available to derive probabilities
Prevention	The management of risk before its occurrence i.e. risk planning
Mitigation	The management of risk after its occurrence i.e. coping
Control and Monitoring	Ensure the execution of the risk plans and evaluate their effectiveness. one can examine the progress made regarding the implemented risk response action plans; corrective actions can be taken if deviations occur in achieving the desired SC performance

Table 9.3 Risk categories adapted from Tummala and Schoenherr, (2011) and Simangunsong, et al. (2012).

Risk Categories	Description adapted from Tummala and Schoenherr, (2011) and Simangunsong, et al. (2012).
Demand risks	Order fulfillment errors, Inaccurate forecasts due to longer lead times, product variety, swing demands, seasonality, short life cycles, and small customer base due to consumer affordability, Information distortion due to sales promotions and incentives, lack of SC visibility, and exaggeration of demand during product shortage
Delay risks	Excessive handling due to border crossings or change in transportation mode, Port capacity and congestion, Custom clearances at ports, Transportation breakdowns
Disruption risks	Natural disasters, Terrorism and wars, Labor disputes, Capacity and responsiveness of alternate suppliers, Regional instability*
Inventory risks	Costs of holding inventories, Demand and supply uncertainty, Rate of product obsolescence, Supplier fulfillment
Manufacturing (process) risks	Poor quality (ANSI or other compliance standards), Lower process yields breakdown, Higher product cost
Physical plant (capacity) risks	Lack of capacity flexibility, cost of capacity
Supplier/procurement risks	Supplier fulfillment errors, Selection of wrong partners, High capacity utilization supply source, Inflexibility of supply source, Single source of supply, Poor quality or process yield at supply source, Supplier bankruptcy, Rate of exchange, Percentage of a key component or raw material procured from a single source, Opportunistic Behavior*
System risks	Information infrastructure breakdowns, Lack of effective system integration or extensive system networking, Lack of compatibility among SC partners, Lack of knowledge about new system, risk of Stakeholders conflicting interest* and legitimacy
Sovereign risks	Communication difficulties, Government regulations, Loss of control, Intellectual property breaches
Supply/ Distribution/Transportation risks	Quality of service, including responsiveness and delivery performance risks, Paperwork and scheduling, Port strikes, Delay at ports due to port capacity, Late deliveries, Higher costs of transportation
Additional Risk Constructs	
Investment Risks*	Can be generated from resource scarcity, or other financial hindrances, lack of financial resources
Domination and Power Structure*	Use of power and pressure from the people in authority. Political influence in an organization that leads to the uncertainty of the execution of a supply chain decision e.g. senior versus junior employees/ managers

Table V Risk management strategies adopted from Simangunsong, et al. (2012).

Reducing Strategies	Description adopted from Simangunsong, et al. (2012).
Lean operations	By making a process leaner, it becomes a simpler process with less inherent uncertainty, (Hines et al. 2004, Taylor, 2006 and Tracy & Knight, 2008).

Product design	Establishing a good initial design or changing the design of a product to enable a better and more robust manufacturing process (Davis, 1993).
Good Decision Support System (DSS)	Refers to the use of decision support systems as a problem solving strategy for complex decision making situations (Shim et al. 2002), (Muckstadt et al. 2001).
Collaboration	Integration, Contractual agreements with suppliers or buyers, Partnership programmes by working more closely with suppliers or customers, for example, in terms of collaborative planning, forecasting and replenishment (CPFR) initiatives (Muckstadt et al. 2001; Christopher & Peck, 2004; Holweg et al. 2005), to reduce uncertainty regarding problems of other members of the supply chain. E-intermediation to facilitate greater information sharing so that adequate information is available for key tasks (Boyle et al. 2008).
Shorter Planning Period	Runs a planning system in a shorter period thereby reducing the last minute changes (Fisher, 1997).
Decision policy & procedures	Refers to the use of better decision policy & procedures to improve supply chain processes. For example, bureaucratic decision making policies require signatures from several people, making it a difficult and lengthy procedure. Therefore, redesigning procedures to reduce the number of signatures will reduce inherent uncertainty (van der Vorst et al. 1998; van der Vorst and Beulens, 2002).
ICT System	A strategy to use application software, computer hardware and communication technology. For example, the use of specific software, e.g., virus-removing software and firewall software, to prevent damage to the IT/IS system caused by software-based attacks (Bandyopadhyay et al. 1999; Greg, 2006).
Pricing Strategy	Refers to the use of a pricing strategy or other incentives to reduce demand uncertainty. Marketing activities such as price promotions could influence end-consumer demand to favour an organisation's plan and hence help with managing uncertainty caused by seasonal demand variability (Miller, 1992; Gupta and Maranas, 2003).
Redesign of chain configuration and/ or infrastructure	Refers to the process of redesigning the supply chain configuration and/or infrastructure, i.e., the plants, distribution centres, transportation modes, production processes and network relationships, which will be used to satisfy customer demands. The redesign of supply chains often leads to big impacts that span large parts of the organisation, and not just incremental changes (Harrison, 2001).
Coping Strategies	Description adopted from Simangunsong, et al. (2012).
Postponement	Delaying activities or processes until the latest possible point in time makes it possible to make things according to known demand rather than to forecast demand (Yang et al. 2004; Yang and Yang, 2010). Toyota, for example, delays decisions on critical specifications until the last possible moment when market information is more definite (Yang et al. 2004).
Volume/delivery flexibility	The agility to manufacture a product despite changes to volume and mix, (Braunscheidel and Suresh 2009). This can be achieved by providing dedicated production facilities or multiple production facilities (van Donk and van der Vaart, 2005), or by using multi–skilled workers (Miller, 1992).

Process flexibility	The flexibility of the workforce, plant and equipment enable a company to cope with uncertainty caused by frequent product changeovers on the shop floor. For example, multi-skilled workers may lead to process flexibility (Miller, 1992). In addition, process flexibility could be achieved through the implementation of general purpose machines, equipment and technologies (Miller, 1992; Ulrich, 1995).
Customer flexibility	Exploiting relationships with customers that are less sensitive to uncertainty issues and are able to adapt their plans. For example, uncertainty caused by unexpected machine breakdowns in the Printed Circuit Board (PCB) industry may be passed to flexible customers who are less sensitive to the problem (Sawhney, 2006).
Multiple suppliers	Exploiting the availability of potential suppliers and their willingness to help an organisation manage its sources of uncertainty. For example, multiple suppliers may enable an organisation to cope with changing production plans caused by production problems by choosing a supplier that provides prompt delivery of raw materials (Sawhney, 2006).
Strategic Stocks	Refers to the use of inventory to buffer against uncertainty (Davis, 1993; Helms et al. 2000; Wong and Arlbjorn, 2008).
ICT System	The availability of a computer based information system to provide information transparency between supply chain partners, which then enables better and faster information flow, but in contrast to one in reducing strategies, this is without reducing the source of uncertainty. For example, an ICT system may facilitate information sharing for managing end-customer demand variations, in terms of cost efficiency and responsiveness to end-customer orders (Mason-Jones and Towill, 1998; Towill and McCullen, 1999; Prater, 2005).
Lead time management	Refers to the quoting of a longer lead time for customer orders compared with the expected manufacturing lead time, (Prater et al. 2001).
Financial risk management	Refers to techniques of financial risk-mitigation such as purchasing insurance, e.g., business interruption insurance, and buying and selling financial instruments, e.g., forward and futures contracts, (Tomlin, 2006; Ritchie and Brindley, 2007). It may also include other financial risk management planning.
Quantitative Techniques	Employing operations research techniques, e.g. forecasting, simulation, and mathematical modelling, to reduce the impact caused by a source of uncertainty, (Piedro, 2009).

Table 9.4 Sustainability performance measurement constructs adopted from Beske-Janssen et al. (2015)

Environment Constructs	Description adopted from Beske-Janssen, et al. (2015)
LCA (product system)	Life cycle assessment is a “cradle-to-grave” approach for assessing industrial systems. “Cradle-to-grave” begins with the gathering of raw materials from the earth to create the product and ends at the point when all materials are returned to the earth. LCA evaluates all stages of a product’s life from the perspective that they are interdependent, meaning that one operation leads to the next. Curran 2006
Env. Reporting	The reports showing the environmental performance.

Eco-Audit	The process of measuring the environmental performance of the focal firms and SC actors.
Env. Benchmarking	The environmental standards against which the environmental performance is compared.
EM (Environmental Management)	Use of environmental management system i.e. instruments or standards particularly targeting to bring environmental benefits.
Env. Standards and certificates	Includes both international and local standards e.g. ISO 14001
Social Constructs	Description adopted from Beske-Janssen, et al. (2015)
Social LCA	Social life cycle assessment is asystematic process using best available science to collect best available data on and report about social impacts (positive and negative) in product life cycles from extraction to final disposal. Benoît et al. 2010
Social Audit/Reporting	The instrument and reports for measuring the social performance of the focal firms and SC actors.
Social Benchmarking	The social standards against which the social performance is compared.
Stakeholder Dialogue	Communication with both traditional and non-traditional stakeholders.
Corporate Citizenship i.e sponsorship, CSR, CSE (entrepreneurship)	Corporate citizenship either for reputational benefits or providing the social solution.
Social Certification	Includes both international and local standards i.e. SA 8000; OHS
Economic Constructs	Description
Financial Audit	"material quality, output quality, new product development, modify product, product improvemen" Adapted from Gunasekaran and Sandhu 2010, p. 132
Financial Reporting	"manufacturing lead time, rate of introducing production, delivery leadtime, due-date performance, frequency of deliver" (Gunasekaran and Sandhu 2010, p. 130)
Financial Benchmarking	"percentage of orders delivered date, average lateness of orders, proportion of products in stock, mean deviation from promised arrival, schedule adherenc" (Gunasekaran and Sandhu 2010, p. 135)

Table 9.5 Performance process and outcome constructs adopted from Maestrini et al. (2017) and Beske-Janssen et al. (2015)

Focus	
Internal	Scope internal supply chain processes
External	Scope external supply chain processes i.e. supplier, customer
	Customer expectation/Satisfaction
	Supplier Improvement/Evaluation
Economic/operational/conventional Constructs	Description adopted from Maestrini, et.al (2017)
Learning And Growth/Capabilities Development	New products developed; New markets entered; R&D spend/sales; Training/sales; Investment/total assets/capability development*
Financial performance	Sales growth, Profit growth, Return on equity, Return on assets , growth in volume of people

Asset	Asset attribute refers to the efficiency and effectiveness of asset utilization measured in terms of cash-to-cash cycle time, return on fixed assets and return on working capital.
Responsiveness	Responsiveness refers to the speed at which tasks are performed
Cost/Scalable	Less cost with greater output i.e. Cost reduction
Reliability	Reliability represents to the ability to perform tasks as expected (perfect conditions of the orders fulfilled)
Agility	Flexibility, adaptability and value at risk
Product Improvement	Continuous improvement in already existing product
Sustainable Competitive Advantage/ Competitiveness	Achieving and maintaining competitive advantage
Information quality	The quality in logistics education, quality of interaction between buyers and suppliers
Resources	Resources have been categorized as physical capital, human capital, and organizational capital (Barney, 1991) and have been extended to include financial capital, technological capital, and reputational capital (Grant, 1991). They may be tangible, such as infrastructure, or intangible, such as information or knowledge sharing (Gro€bler and Grubner, 2006). Resources are "something a firm possesses or has access to, not what a firm is able to do" (Gro€bler and Grubner, 2006, p. 460)
Environmental Constructs	Description
Waste production	The production of unwanted materials as a by-product of economic processes (Sustainable Development Indicator Group, 1996).
Green House Gas Emission/ Pollution	The emissions of harmful gases into the air is called air pollution because they alter the chemical composition of the natural atmosphere. (adapted from Daly and Zannetti 2007)
Noise Pollution	Noise pollution is generally defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms (Environmental Pollution Centres, 2019).
Recycling	Recycling means the processing of waste (i.e., unwanted or useless materials) and its (re)introduction back into the material cycle so that contamination of the environment is minimised. (Tanskanen 2013)
Environmental Performance	Environmental benefit achieved as a result of business activity—that is, energy consumed, waste produced, improved air quality, and so on.
Social Constructs	Description
Gender Diversity	It is the proportion of males to females in an organisation that can affect the way in which they interact and behave with one another at the workplace, and thereby impact the social and cultural environment (IGI Global, 2020).
Fair Trade	Fairtrade means that the producers receive prices that cover their average costs of sustainable production, the premium which can be invested in projects that enhance social, economic and environmental development (Fairtrade International, 2019).
Human Rights	Human rights include the right to life and liberty, freedom from slavery and torture, freedom of opinion and expression, the right to work and education, and many more. Everyone is entitled to these rights without discrimination (United Nations, 2020).
Fair Labor	“This includes paying less than the minimum wage, employing young children, and working employees for long hours without premium overtime pay” (Goldstein et al. 1999, p. 1003).

Local Community Commitment	LCC means, taking the long-term view of, the embeddedness of firms into local communities to deal with the local contestations for survival that filter into everyday lives of the poor (Ansari, S., Munir, K., and Gregg, T., 2012).
Social Benefit/Social performance	Social benefits achieved as a result of a business activity—poverty alleviation, empowerment, inclusiveness, and so on.
Integrative/Sustainability Development	Sustainability without focusing on particular dimension i.e. meets the needs of the present, without compromising the ability of future generations to meet their own needs. The integrative aspect in addition provides the means to include environmental and social management into the conventional economic management.
Additional Constructs	
Internationalization performance/BoP performance	Investment intensity, Geographic concentration, Geographical extensity
Employee/ Intrapreneuralship	The proactivity of employees within an organization i.e. self-motivated, action oriented
Relationship performance	Social Capital
	Trust
	Commitment (supply chain actors)
	Integration
Empowerment	Empowerment means meeting the need of individuals along with increasing their productivity and income level (Mensa et al. 2010)
Mutual Benefits/ Value creation/win-win	Aventure's ability to generate acceptable economic returns to their investors and provide valued societal returns to the local community in which they operate
Innovation	Innovation here is largely regarded as a new ways or new innovative products delivered to the poor concentrating on their specific needs.

*****Additional explanation of the constructs frequently observed in BoP literature**.**

9.3. Appendices of Chapter 5:

Figure 9.1 Study process

The original questionnaires of the three rounds of the Delphi-study are available at: doi:10.17170/kobra-202205066

Table 9.6 Part 1: Job titles of respondents (between zero and two entries per respondent possible)

Job Titles	Frequency round 1	Frequency round 2	Frequency round 3
Academia in total	**77**	**96**	**90**
Full Professor	41	40	37
Assistant Professor	17	19	26
Associate Professor	8	15	10
Lecturer	8	16	13
Postdoctoral Fellow	0	1	1
PhD candidate	2	5	3
Research coordinator	1	0	0
Industry in total	**8**	**26**	**15**
General Manager	0	7	2
Supply Chain Manager	2	2	1
Regional/Branch Manager	2	1	2
CEO / General Director	1	1	4
Industrial Development Manager	1	1	1
IT Engineer / Consultant	1	2	0
Logistics Manager	1	5	2
Sustainability Manager	0	3	0
Industrial Engineer	0	1	0
Project Manager	0	3	3

Table 9.7 Part 2: Respondent data round 1 (for institutional sectors: between one and five entries per respondent possible)

Region	Number of round 1 respondents	Respondents expertise in academia and industry			Respondents involvement in institutional sectors (Academia, Industry, Non-Governmental Organization (NGO), Governmental Organization (GO), other)				
		Years of experience in academia (mean)	Years of experience in industry (mean)	Year of PhD completion (mean, if applicable)	One sector	Two sectors	Three or more sectors	No answer	Currently working in industry
Africa	15	14.17	11.83	2014	5	5	2	3	7
Brazil	9	15.67	15.22	2013	8	1	0	0	1
China	14	17.29	1.43	2012	14	0	0	0	0
Europe	21	14.33	5.05	2009	18	3	0	0	3
North America	12	26.91	5.18	2009	8	2	1	1	3
India	2	8.05	5.45	2008	2	0	0	0	0
Pakistan	3	13.00	6.33	2008	2	1	0	0	1
Iran	19	7.89	5.89	2009	12	2	4	1	7
Total sample	**95**	**15.06**	**6.34**	**2007**	**69**	**14**	**7**	**5**	**22**

A total of 71 experts from eleven African countries (Namibia, Nigeria, South Africa, Kenya, Ethiopia, Egypt, Cameroon, Ghana, Tanzania, Morocco, Uganda) were contacted to take part in the study. The majority of round one respondents are located in Kenya, with other respondents in Ghana, Namibia, and South Africa. For four respondents, the country of residence within Africa is not known.

Table 9.8 Part 3: Respondent data round 2 (for institutional sectors: between one and five entries per respondent possible)

Region	Number of round 2 respondents	Respondents expertise in academia and industry			Respondents involvement in institutional sectors (Academia, Industry, Non-Governmental Organization (NGO), Governmental Organization (GO), other)				
		Years of experience in academia (mean)	Years of experience in industry (mean)	Year of PhD completion (mean, if applicable)	One sector	Two sectors	Three or more sectors	No answer	Currently working in industry
Africa	17	12.06	10.76	2011	15	2	0	0	1
Brazil	20	17.70	13.15	2010	15	4	1	0	6
China	16	12.06	4.50	2011	16	0	0	0	4
Europe	29	17.21	5.48	2008	23	5	0	1	5
North America	8	16.43	15.14	2003	5	2	0	1	2
India	14	7.07	0.79	2018	10	4	0	0	4
Pakistan	4	6.00	4.75	2021	4	0	0	0	0
Iran	16	8.25	4.63	2017	8	7	1	0	7
Total sample	**124**	**13.27**	**7.16**	**2011**	**96**	**24**	**3**	**2**	**29**

Table 9.9 Part 4: Respondent data round 3 (for institutional sectors: between one and five entries per respondent possible)

Region	Number of round 3 respondents	Respondents expertise in academia and industry			Respondents involvement in institutional sectors (Academia, Industry, Non-Governmental Organization (NGO), Governmental Organization (GO), other)				
		Years of experience in academia (mean)	Years of experience in industry (mean)	Year of PhD completion (mean, if applicable)	One sector	Two sectors	Three or more sectors	No answer	Currently working in industry
Africa	10	15.70	6.00	2011	6	2	2	0	4
Brazil	21	18.86	13.81	2009	13	4	0	4	7
China	16	12.69	3.31	2012	15	1	0	0	3
Europe	24	14.96	5.00	2010	21	2	0	1	3
North America	5	25.25	2.25	2000	4	0	0	1	0
India	13	11.17	1.50	2015	9	3	1	0	4
Pakistan	10	9.33	4.89	2019	4	2	4	0	6
Iran	18	11.33	9.22	2014	12	5	1	0	6
Total sample	**117**	**14.37**	**6.67**	**2011**	**84**	**19**	**13**	**6**	**33**

The African participants were located in South Africa and Uganda, and one each in Kenya, Namibia, and Morocco. Therefore, a broad geographical and economic range of the continent is represented.

Table 9.10 Results of the content analysis

Construct *Definition*	
Q1: Vulnerabilities	**Q2-4: Responding measures, resilience building, restoring operations**
Supply network *A network of interdependent relationships within and between interdependent organizations, which developed and fostered through strategic collaboration with the goal of deriving mutual benefits (Chen and Paulraj, 2004; Stock and Boyer, 2009).*	
Challenges in supply network management - Dependencies (few suppliers/ China) - Missing diversification - Lack of coordination between partners - Missing transparency	**Strengthening supply network adaptation and collaboration** - Increase cooperation and trust between SC partners - Create open channels for communication and information - Redesign supply network; nearshoring, reshoring, local sourcing - Seek alternative suppliers/ dual sourcing - Improving customer relationship/ service
SC volatility *"(…) an era of turbulence, that will feature higher variance in key business parameters: from energy cost, to raw materials, and currency exchange rates (Christopher and Holweg, 2011)*	**SC agility** *An agile supply chain possesses qualities such as increased velocity to quickly adapt to unexpected changes in demand or supply, acceleration to speed up the reaction time and responsiveness to react to changes. (Ali et al. 2017)*
SC volatility - Shifting demand pattern - Changing customer requirements - Shifting workforce availability - Required changes in production capacities	**Increasing SC agility** - Shifting or cancelling orders - Adjusting production and delivery schedules - Capacity and resource reduction - Shift materials and products, simplify and reduce products - Build up inventory/ safety stock - Develop in-house capabilities
Logistics *"Logistics is the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organisation and its marketing channels in such a way that current and future profitability are maximised through the cost-effective fulfilment of orders." (Christopher, 2017)*	
Logistical challenges - Travel and transport restrictions (closed borders, quarantine, traffic controls) - Challenges in reaching markets/ customers - Limited transport capacity/ vehicles/ drivers - Stockouts vs. too much stock	**Improving logistics performance** - Increased cooperation with logistics service providers - Switch to alternative transport options - Increase safety stock - Reduce stock keeping units

	- Restrict customer service and purchase quantity per customer
Workforce/ HRM and hygiene management *Implementation of management principles for managing the workforce of an organization, concerned with the process of employee recruitment, training, developing and retaining manpower, with a view to making them more efficient and reward management. (Pauuwe and Boon, 2019)*	
Challenges in workforce/ HRM and hygiene management - Workplace safety & hygiene - Labour shortage (illness, locked out of country) - Remote work	**Improving HRM and hygiene management** - reduce working hours/ temporary workers/ layoffs vs. recruit employees/ transfer from other companies - Implementation of hygiene safety measures and protocols - Promote flexible working hours and teleworking - Promote innovation and creativity of employees
Digitalization *Digitalization covers changing business models, enhancing supply chain visibility and automating structures and processes (Antikainen et al. 2018; Holmström et al. 2019; Zeranski and Sancak, 2020)*	
Challenges in digitalisation - Missing visibility - Low governance on chain engineering	**Enhancing digitalisation** - Move to online-based platforms/ E-commerce - Build up IT capabilities - Usage of virtual collaboration tools, teleworking - Implementation of information and ERP systems, tracking devices
Finance *An academic discipline within the general field of economics dealing with financial markets, and the funding implications for managing businesses (Law, 2016).*	
Financial challenges - Loss of income/ sales - Increased costs - Lack of investments - Currency devaluation	**Improving financial management** - Apply for financial support (government, insurance) - Extent bank loans - Cost reduction analyses - Increase price - Postpone payments - Salary cuts & employee dismissals - Sharing of transport vehicles - Build up cash reserves
Government *The institutions, rules, and administration of state authority (Brown, 2018).*	
Governmental regulations - Increased unemployment - Poverty	**Receiving government support** - Financial support - Usage of state facilities - Equipping health facilities - Regulate rationing - Undertake inspections

SC disruption(s) (only in Q1)	**RM culture, knowledge and system (not in Q1)**
"Literally, disruption is defined as ''the action of rending or bursting asunder; violent dissolution of continuity; forcible severance''. Sphere of action and duration of effect are graver than in the case of disturbance. (...) Disruption has a strong negative impact normally of wide scope and long duration of effect." (Pfohl et al. 2010)	*''The management of supply chain risks through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity."(Tang, 2006) Risk culture ''presence of shared values, beliefs, assumptions, and patterns of behaviour'' (McAfee et al. 2002)*
SC disruption(s) - Demand uncertainties (panic buy, cancelled orders) - Lack of supplies/ raw materials/ products - Disruptions in transportation - Closed plants and insufficient production capacity	**Establishing risk management culture, knowledge and system** - Establishing cross-functional teams - Training to build key know-how - Redesign business model - Incident response and contingency plans - Diversify SCs to reduce dependencies - Analyse risks and monitor course of pandemic
SC disturbance(s) (only in Q1) *''Literally, disturbance can be defined as ''the interruption and breaking up of tranquillity, peace, rest, or settled condition''. (...) They usually lead to negative impacts for a limited period and parameter only and can be prevented by measures such as buffers." (Pfohl et al. 2010)*	
SC disturbance(s): - Longer lead time/ delays - Price fluctuation	

9.4. Appendices of Chapter 6:

Table 9.11 Qualitative data analysis

Exemplary Quotes	**First Condensation**	**Second Condensation**	**Third Condensation**	**Definition**
Vulnerabilities				
"Local manufacturing/ sourcing there by reducing the dependence on overseas supplies" "Loss of demand balance among supply chain members"	Local manufacturing Demand imbalance	SC network design issues Collaboration issues	Challenges in supply network management	A network of interdependent relationships within and between interdependent organisations, which developed and fostered through strategic collaboration with the goal of deriving mutual benefits. (Chen & Paulraj, 2004).
"Disruptions to the availability of goods sourced from China; both finished goods for sale and products used in factories in developed markets"	Disruptions of goods from China	Supply disruption	SC disruption(s)	"Disruption has a strong negative impact normally of wide scope and long duration of effect." (Pfohl et al. 2010, p. 34)
"Dismissal of employees and Closing of some sections of the factory"	Loss of production capacity Loss of productivity	Loss of performance	SC disturbance(s)	"Literally, disturbance can be defined as ''the interruption and breaking up of tranquility, peace, rest, or settled condition''. (...) They usually lead to

				negative impacts for a limited period and parameter only and can be prevented by measures such as buffers." (Pfohl et al. 2010, p. 34)
"Some service industries like tourism, hospitality and airlines are totally bankrupted due to the COVID-19 because they have lost majority of their customers"	Loss of majority of customers	Demand shock	SC volatility	"An era of turbulence, that will feature higher variance in key business parameters: from energy-cost, to raw materials, and currency exchange rates." (Christopher and Holweg, 2011, p. 65)
"Because of COVID 19, industries are facing problems to distribute the items to customers."	Lack of distribution channel	Connectivity issues	Logistical challenges	"Logistics is the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organisation and its marketing channels in such a way that current and future profitability are maximised through the cost-effective fulfilment of orders." (Christopher, 2017, p. 2)
"Shortage of masks, disposable gloves and disinfectant liquids" "Employee dismissal"	Shortage of hygienic commodities Employee dismissal	Challenges in retaining manpower and implementation of management principles	Challenges in workforce/HRM and hygiene management	Implementation of management principles for managing the workforce of an organisation, concerned with the process of employee recruitment, training, developing and retaining manpower, with a view to making them more efficient and reward management. (Paauwe and Boon, 2018)
"Dry economy with no cash flows or cash in hand of consumers to indulge in purchase activity other than most essential items."	No cash flow or cash in hand	Lack of finance	Financial challenges	"Every decision that a business makes has financial implications, and any decision which affects the finances of a business is a corporate finance decision." Costs occur in all relevant business units at different business activities. (Damodaran, 1996, p. 1; Blocher et al. 2019)
"Labour migration and rise in unemployment levels due to unemployment people are starving and looking for all avenues to get something to eat, malnutrition of children"	Labour migration and poverty	Regulatory, legal & bureaucratic	Governmental regulations	Regulations set by the institutions, rules, and administration of state authority. (Brown et al. 2018)
Response measures, Resilience to mitigate future risk, Restoration				
"Broad base suppliers in other countries, look for alternative products/ raw materials Near shore the suppliers and build factory within factory"	Alternate supplier Near shore supplier	Change in SC design or structure	Strengthening supply network adaptation and collaboration	A network of interdependent relationships within and between interdependent organisations, which developed and fostered through strategic

				collaboration with the goal of deriving mutual benefits. (Chen and Paulraj, 2004).
"Create more contingency reserves for businesses in areas most affected by the crisis. This will increase maintenance costs including sleeping capital, spoilage of perishable raw materials and more inventory maintenance costs, but will also prevent the loss of existing customers" "Shifting the manufacturing lines of other hygiene products to provide masks, disposable gloves and disinfectant liquids"	Inventory management Diversification	Responsiveness	Increasing SC agility	Adaptability, velocity and acceleration, responsiveness, speed (Ali et al. 2017)
"Moving and transferring the ready-made inventories of the companies supplying raw materials outside the quarantined areas and to the nearest place where the facilities for transferring and sending them are provided by the supplying companies. This will increase the costs of relocation and maintenance due to the accumulation of goods in new warehouses, but in turn will increase the stability of the supply chain"	Movement and storage of materials, parts and finished inventory	Inventory movement	Improving logistics performance	"Logistics is the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organisation and its marketing channels in such a way that current and future profitability are maximised through the cost-effective fulfilment of orders." (Christopher, 2017, p. 2)
"Recognition of health and safety training" "Adjusting the workforce"	Hygiene awareness HR readjustment	Hygiene management HR management	Improving HRM and hygiene management	Implementation of management principles for managing the workforce of an organisation, concerned with the process of employee recruitment, training, developing and retaining manpower, with a view to making them more efficient and reward management. (Paauwe and Boon, 2018)
"Use of non-face-to-face communication tools"	Use of technology	Applying digitising techniques	Enhancing digitisation	"The sociotechnical process of applying digitising techniques to broader social and institutional contexts that render digital technologies infrastructural" (Tilson et al. 2010, p. 2)
"Salary reductions to improve financial situation"	Salary reduction	Cost cutting	Improving financial management	Financial strength: Capacity to absorb fluctuations in cash flow, e.g. Insurance, Financial reserves and liquidity, Price margin. (Pettit et al. 2010)
"Support from Government via request of loans for businesses"	Government support	Government support	Receiving government support	Receiving government relief packages etc.
"Conduct scenario analyses to identify specific actions" "Educate employees on COVID-19 symptoms and prevention"	Analysing risk and related strategies Training employees	Risk awareness and organisational learning	Establishing risk management culture, knowledge and system	Supply chain understanding, education and training, supply chain drills, simulations and exercises, SCRM/SCRES culture, board-level leadership, risk-management department, risk awareness, inter-organisational learning (Ali et al. 2017)

Social Capital				
"The social capital and trust between stakeholders of the firm play a vital role in this context. If people trust to each other, the employees are assured that the employers and business owners do their best, they will have peace of mind and are engaged with their companies" "The goodwill among suppliers, customers, and employees is suppressing transnational behaviour and enhancing collaboration which is key managing disruption and continuing functioning"	Trustworthiness, Goodwill among SC partners	Interpersonal relation based on trust and friendly interactions	Relational capital	"Relational capital regards the assets gained through or rooted in interpersonal relationships. It describes the quality of interpersonal relationships and how they develop and strengthen over time. Relational-capital facets include interpersonal relationships characterised by close interaction, friendship, trust, respect, reciprocity, and identification with and commitment to the collective." (Polyviou et al. 2019)
"I think Social capital is an important topic but being loyal to a brand (by customers) and improvement of organisational image (by stakeholders) are much more important. During pandemic of covid-19, the social responsibility of firm's (to relieve the pains of people or community) help them to regain what they have lost"	Loyalty, organisation image, understanding social responsibility	developing common understanding of goals, norms	Cognitive capital	"Cognitive capital regards 'the resources providing shared representations, interpretations, and systems of meaning' among a network's actors. Cognitive capital is created as network actors interact with each other over time, learn network-specific skills and knowledge, and develop a common understanding of goals, norms and ways of acting in the collective." (Polyviou et al. 2019, p. 72)
"Identify innovative opportunities to develop new / alternative products or services in the current supply chain context"	Helps in easing of operational activities	Fast re-routing of requirements Process Improvement	Ease adaptability-modifying operations, alternate technology	The fast re-routing of requirements, process Improvement, lead time reduction, strategic gaming & simulation, seizing advantage from disruptions, alternative technology development, learning from experience, reengineering. (Pettit et al. 2020)
"It is very important and valuable because in times of viral crisis, it is the social capital of companies that helps to use all its capital to support the people's community in order to be in line with the people and mobilise the people in order to achieve good understanding, solidarity and collective sacrifice. The first is to meet the needs of society so that the company's profits can be met so that they can overcome the crisis en mass"	Helps understanding customer needs	Establishing profitable relationship	Ease customer relationship management	"Customer relationship management (CRM) comprises a set of processes and enabling systems supporting a business strategy to build long term, profitable relationships with specific customers." (Ling and Yen, 2001, p. 85)
"Use innovative and innovative ideas of current customers to redesign the dimensions of the business model and Investigate the possibility of building strategic alliances with other business supply chains"	Redesign dimensions and building strategic alliance	Network configuration	Structural capital	"Structural capital regards the links among a network's actors and the pattern of those links; (…) It thus describes the impersonal attributes of relationships. Structural-capital facets include the presence/absence of ties among a network's actors and network configuration described based on size, density, connectivity and hierarchy." (Polyviou et al. 2019, p. 71)

Table 9.12 Contingency analysis values in phi-coefficient (φ)

Questions	Contingencies	Source	Make	Deliver
Response measure	Challenges in supply network management * Establishing risk management culture, knowledge and system			0.31*
Future risk mitigation	Challenges in supply network management * Strengthening supply network adaptation and collaboration			0.373*
Restoration	Challenges in supply network management * Receiving government support			0.45**
Response measure	Challenges in supply network management * Strengthening supply network adaptation and collaboration			0.369*
Future risk mitigation	SC disruption(s) * Increasing SC agility	0.414**		
Restoration	SC disruption(s) * Increasing SC agility	0.474**		
Response measure	SC disruption(s) * Receiving government support		0.326*	
Future risk mitigation	SC disruption(s) * Strengthening supply network adaptation and collaboration		0.306*	
Restoration	SC disruption(s) * Enhancing digitisation		0.455**	
Restoration	SC disruption(s) * Receiving government support		0.455**	
Response measure	SC disruption(s) * Enhancing digitisation		0.371*	
Response measure	SC disruption(s) * Receiving government support			0.453**
Response measure	SC disruption(s) * Establishing risk management culture, knowledge, and system			0.418**
Restoration	SC disruption(s) * Receiving government support			0.559**
Future risk mitigation	Financial challenges * Improving financial management	0.471**		
Restoration	Financial challenges * Improving financial management	0.516**		
Future risk mitigation	Financial challenges * Improving HRM and hygiene management			0.437**
Future risk mitigation	Financial challenges * Improving financial management			0.389*
Restoration	Financial challenges * Increasing SC agility			0.373*

**p<0.01; *p<0.05