



Unveiling ‘Blind Spots’ in Tier-level Supply Chain Operations: A Systematic Review Towards Developing End-to-End Visibility

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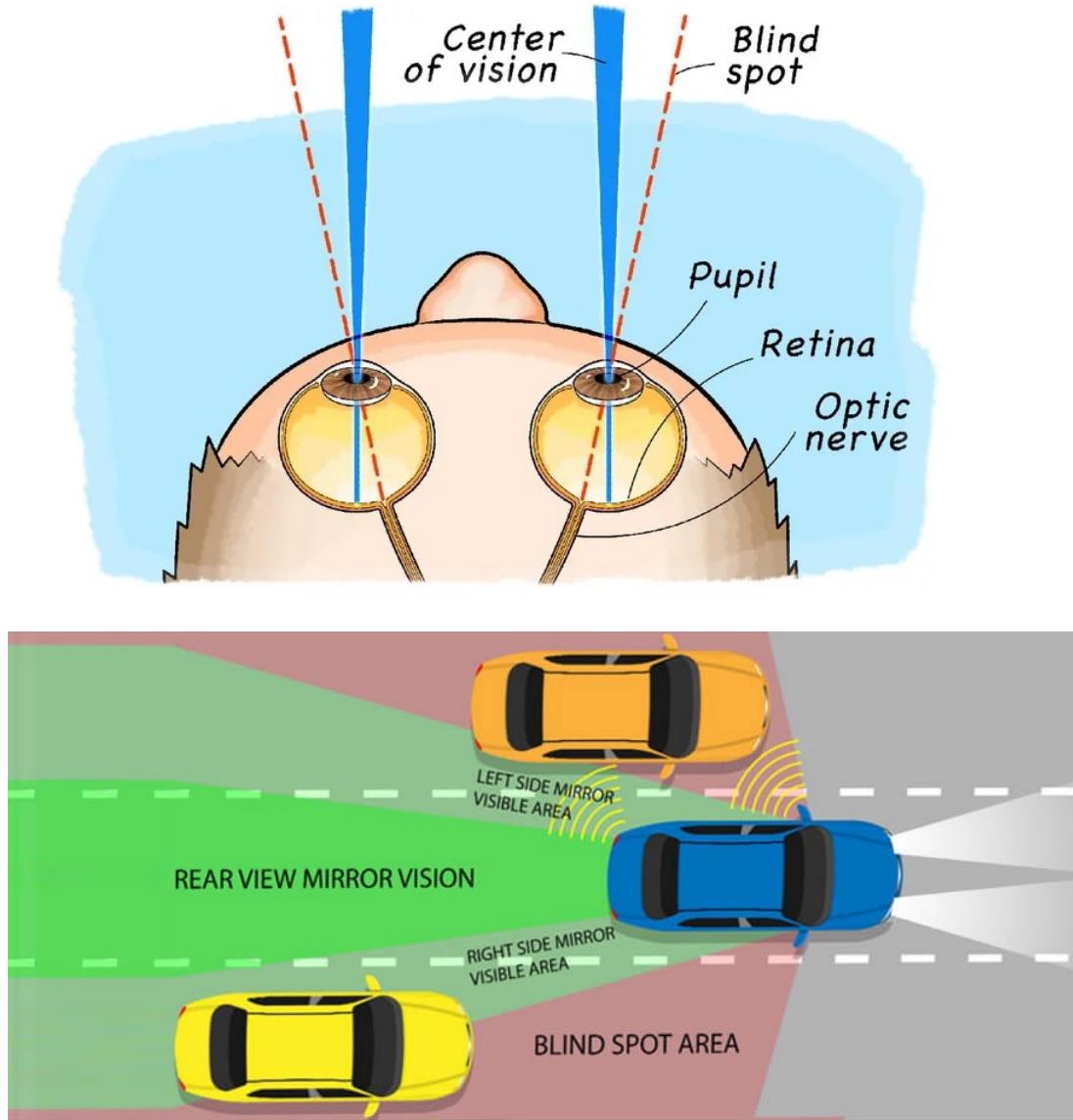
05 Discussion



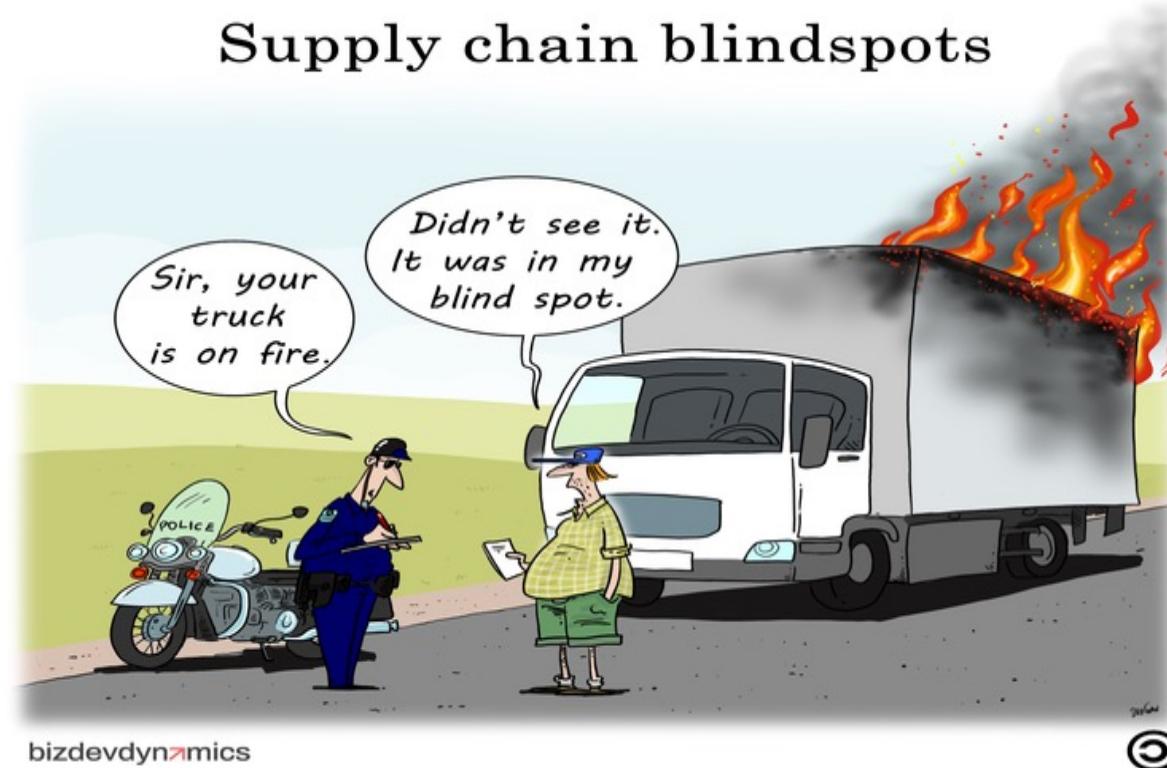
06 Conclusion



Background – Blind Spots



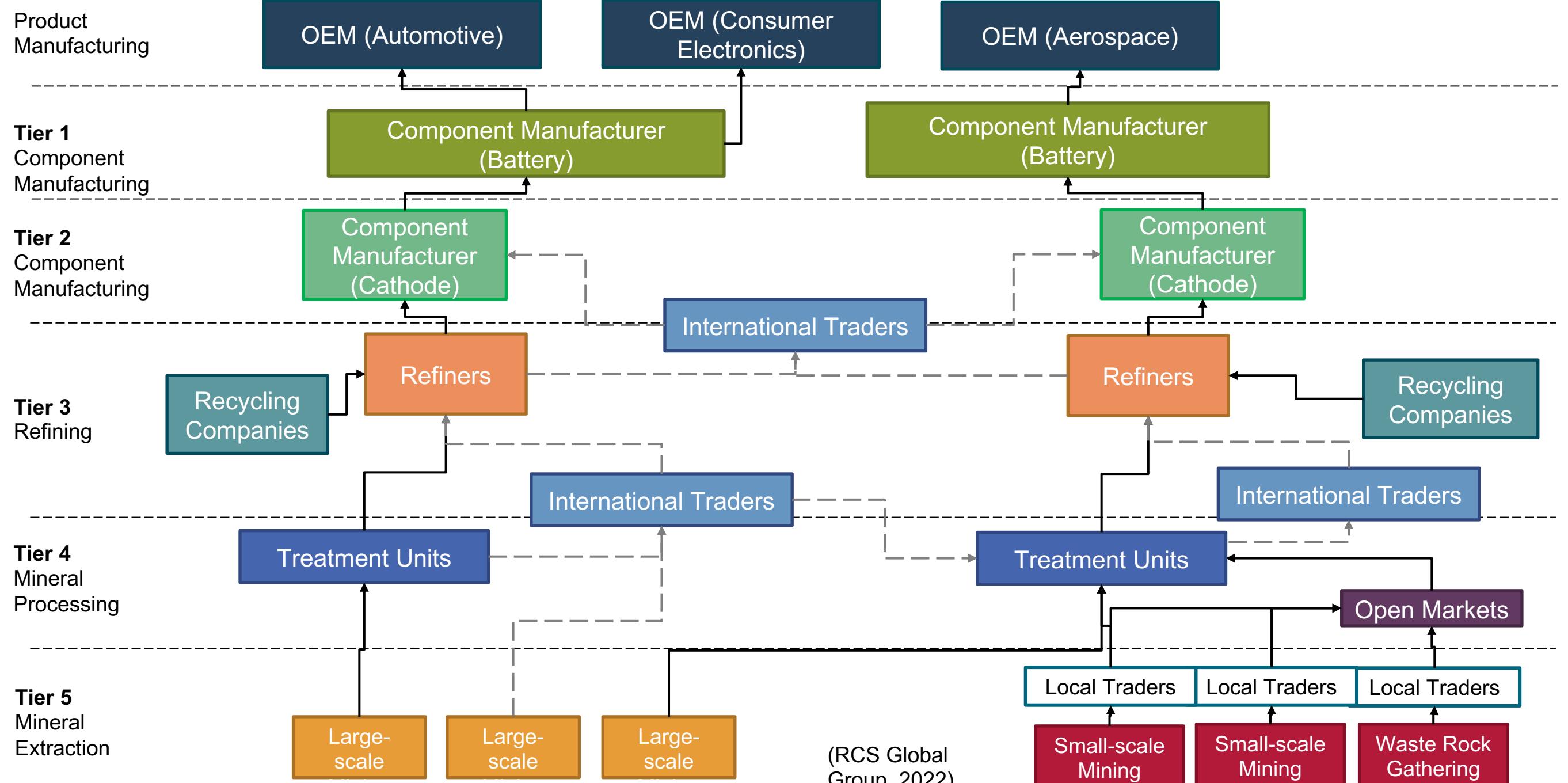
Supply chain blindspots



“A blind spot is **an area in your range of vision that you cannot see properly but which you really should be able to see**”

(Collins Dictionary, 2023)

Research Context - Supply Chain Blind Spots



Research Context – Industrial Problems

Tesla pauses German production after Red Sea shipping attacks

Delays in delivery of parts result in suspension of manufacturing at factory near Berlin for two weeks

● Middle East crisis - latest updates



Source: Tesla (2024)

OEM (Consumer Electronics)

Source: Guardian (2019)

Resource extraction responsible for half world's carbon emissions

Extraction also causes 80% of biodiversity loss, according to comprehensive UN study



Tier 4
Mineral Processing

Treatment Units

Tier 5
Mineral Extraction

Large-scale

Large-scale

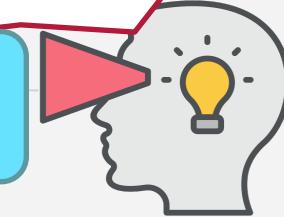
Large-scale

(RCS Global Group, 2022)

Existing digital infrastructure (e.g., Supply chain control tower) has limited data capability

Limited supply chain visibility, usually only till Tier 1,2 (Who? What? How?)

Industrial Problems



Source: The Independent (2023)

'Here it is better not to be born': Cobalt mining for Big Tech is driving child labor, deaths in the Congo



Small-scale Mining

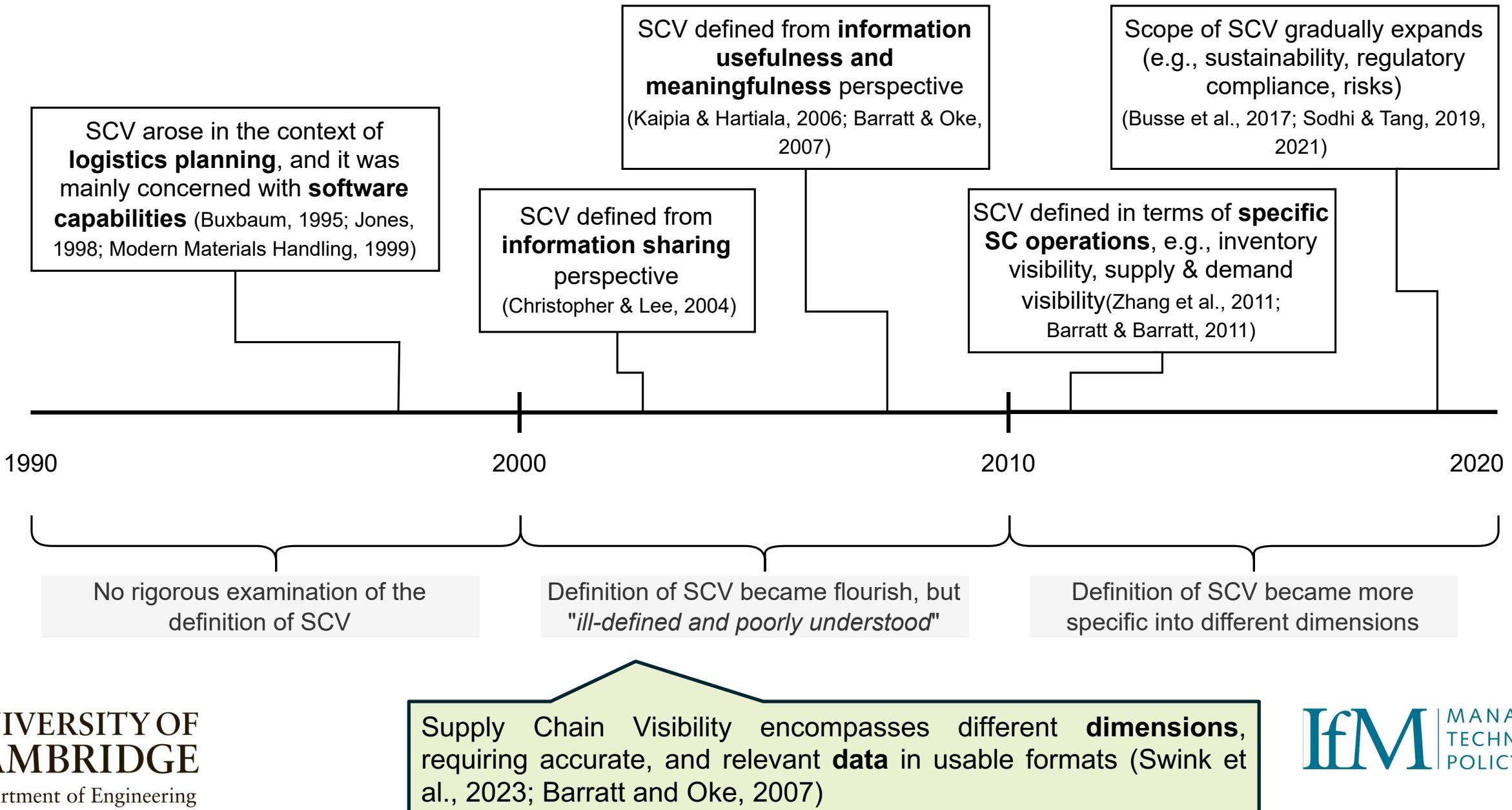
Small-scale Mining

Waste Rock Gathering

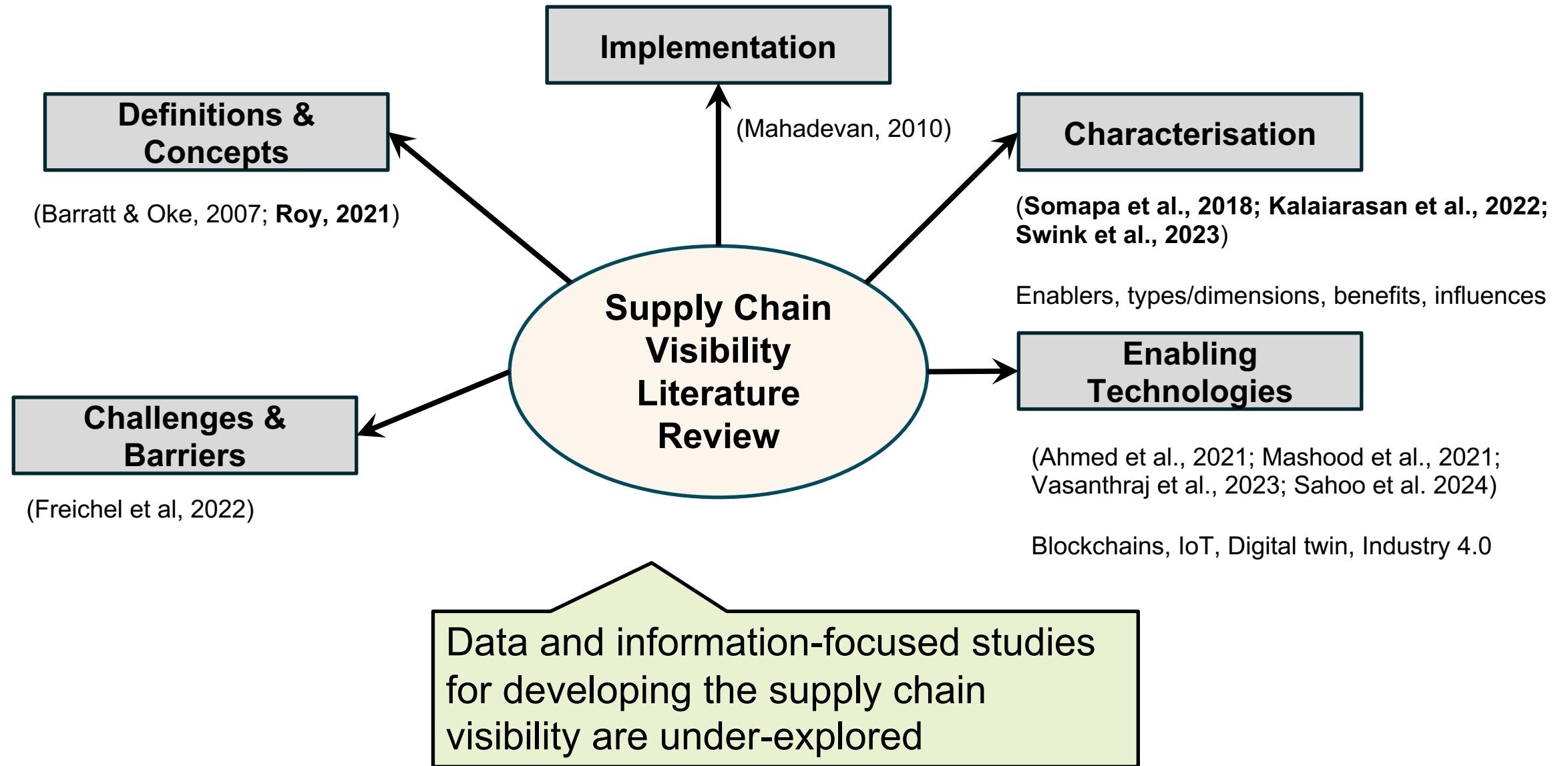


Research Context – Supply Chain Visibility

We need **Supply Chain Visibility** to uncover these ‘Blind Spots’



Research Context – Existing Reviews



Research Questions & Objectives

Questions:

RQ1: What are the current data-related **practices** and **challenges** for developing visibility into multi-tier supply chains?

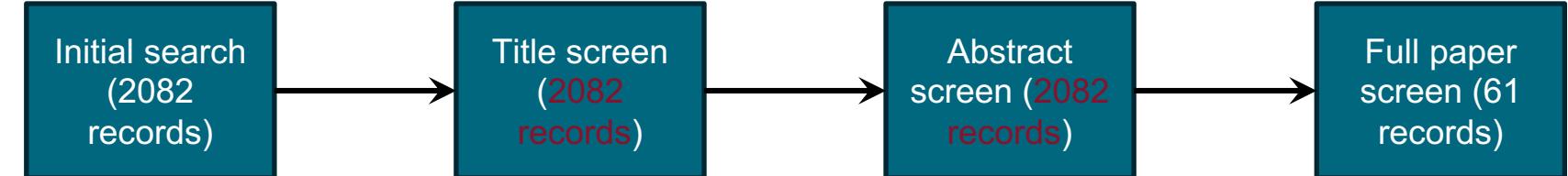
RQ2: How to **develop** the supply chain visibility within the multi-tier supply chains through data?

Objectives:

- To **analyse the current research landscape** of supply chain visibility from a data perspective, identifying the types of data utilised and the methodologies employed in existing research
- To **develop a comprehensive guideline** for the collection, utilisation, and analysis of data, aimed at enhancing visibility within multi-tier supply chains

Research Design

Systematic Literature Review (Denyer and Tranfield, 2009)

Stages	Activities	Details
1 – Planning	Research question	RQ1: What are the current data-related practices and challenges for developing visibility in multi-tier supply chains? RQ2: What are the strategies to address these challenges and enhance supply chain visibility?
2 – Research Identification	Search database	Web of Science
	Search string & field	Keywords related to three topic: (1) Supply chain (2) Multi-tier (3) Data exploitation
	Search filters	Publication time: Last 10 years Language: English Document type: Articles Journal: Only ABS listed and scores ≥ 2
3 – Evaluation & Selection	Title, Abstract, and Full-text screening	Focus on empirical research that studied multi-tier real-life supply chains  <pre> graph LR A[Initial search 2082 records] --> B[Title screen 2082 records] B --> C[Abstract screen 2082 records] C --> D[Full paper screen 61 records] </pre>
4 – Synthesis & Analysis	Descriptive analysis	Keyword co-occurrence analysis using VOSViewer
	Content analysis	Extracted article information of (1) Scope and application: SC structure, sector, objective, SCV dimension (2) Data exploitation: data source and collection, data pre-processing, data storage, data elements, data analysis method, data type, analytics type, decision type
5 – Reporting & Discussion	Result reporting and knowledge establishment	Answer research question; Raise research gap; Identify future research avenue; Develop guidelines for data exploitation
	Review quality and result validation	Cross-validated among researchers; Validated with industrial experts from Google

Research Design

Supply chain visibility dimensions

Dimension	Sub-dimension	Data Elements (example)
Product visibility	Product characteristics visibility	Product structure, quality information
	Product use visibility	Product recycling, disposal
Supply visibility	Raw material visibility	Origin of raw materials
	Supplier visibility	Supplier capacity
	Inventory visibility	On-hand inventory level
	Transportation/ Logistics visibility	Product/material location, lead time
Demand visibility	Demand pattern visibility	Sales information
	Market visibility	Market rules and policies
Risk visibility		Risk source (political instability, climate change event)
Sustainability visibility	Sustainability performance visibility	Energy consumption, gender ratio
	Sustainability practice visibility	Suppliers' compliance certificates
Process visibility	Production process visibility	Bill-of-Material, production plan
	Structural visibility	OEM location, supplier location
	Financial visibility	Capital cost, investment

Research Design

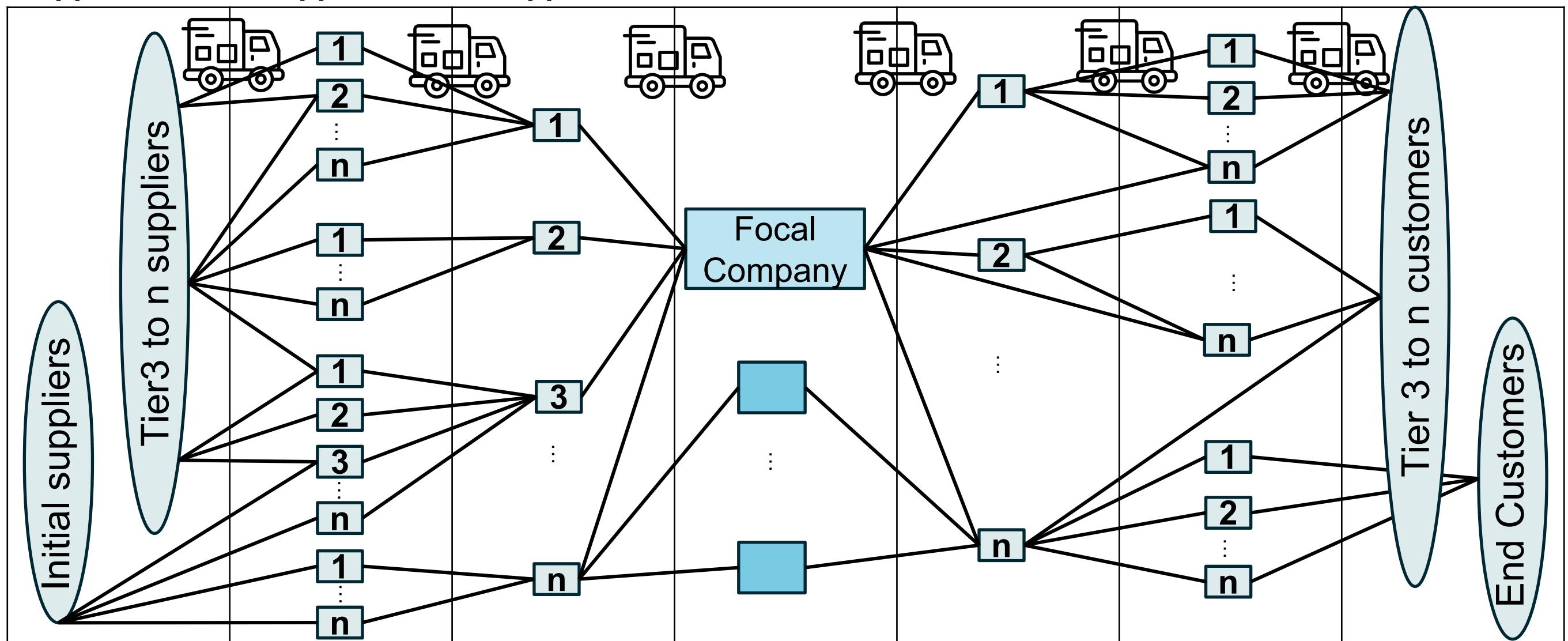
Basic Structure of a multi-tier supply chains

(Lambert et al., 1998)

Carriers

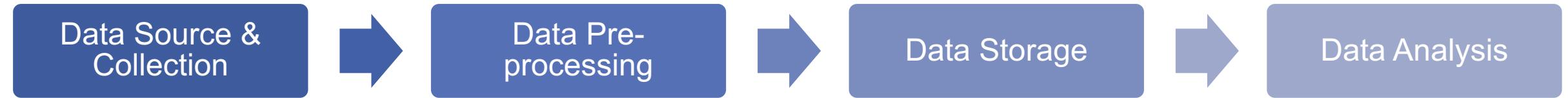


Beyond tier-2 suppliers Tier-2 suppliers Tier-1 suppliers Manufacturers Wholesalers/ Distributors Retailers Consumers/ End-customers



Research Design

Data Exploitation Processes



Data source types

- Publicly available data
- Private company data
- Commercial data
- Hypothetical data
- Synthetic data

Steps of validating the data and data quality improvements

Research data storage and management (e.g., database)

Data analysis methods to generate information for supply chain visibility

Data collection methods

- Interviews
- Online databases
- Field visits
-

Adapted from big data analytics

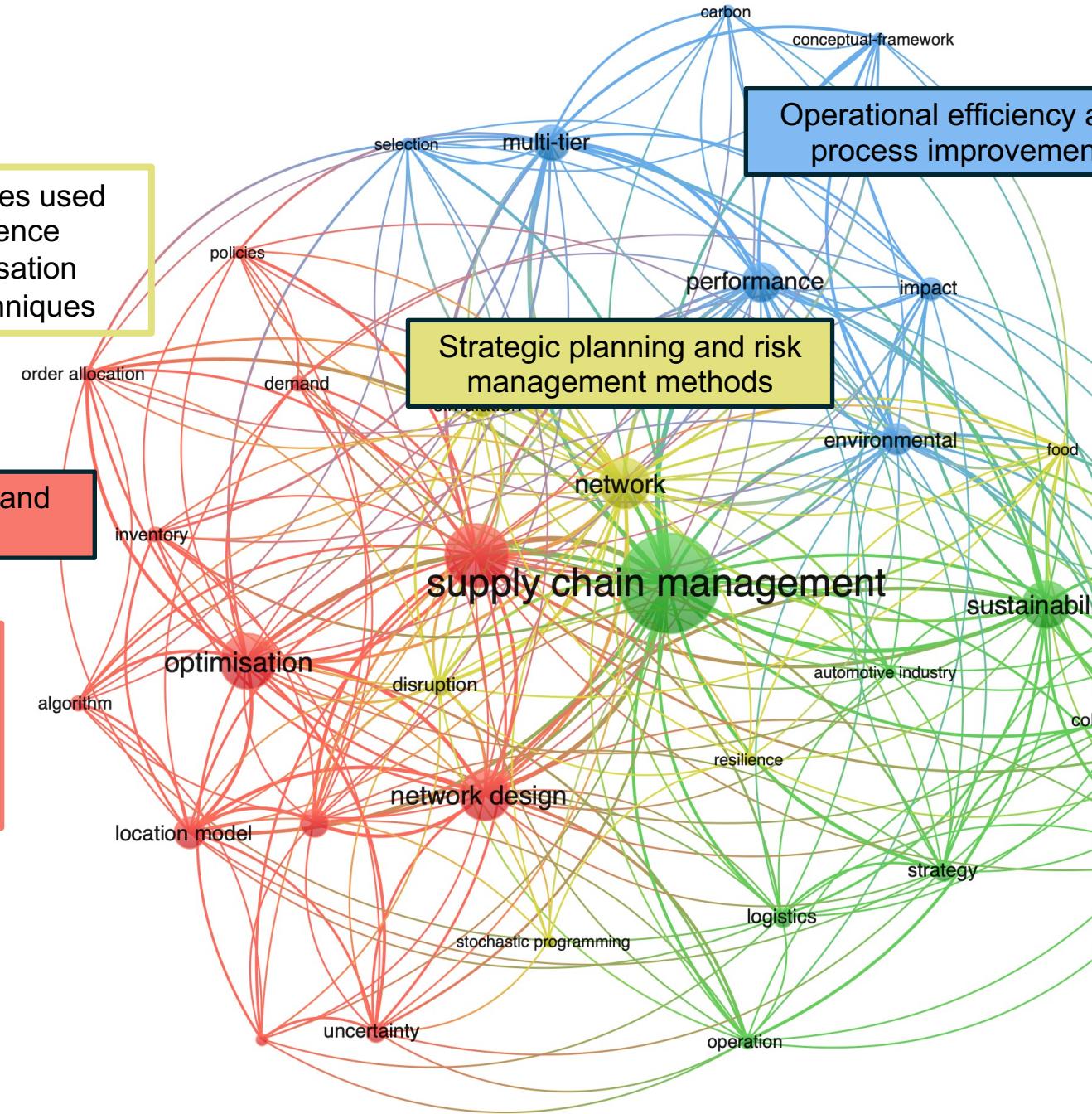
Findings (1) – Supply Chain Visibility Research Themes

Objectives of studying multi-tier supply chains

Methodologies and technologies used for risk identification and resilience development, including optimisation algorithms and simulation techniques

Supply chain design and performance

Formulation of long-term strategies, design of supply network structures for various purposes such as reverse logistics, SC optimisation, and uncertainty management

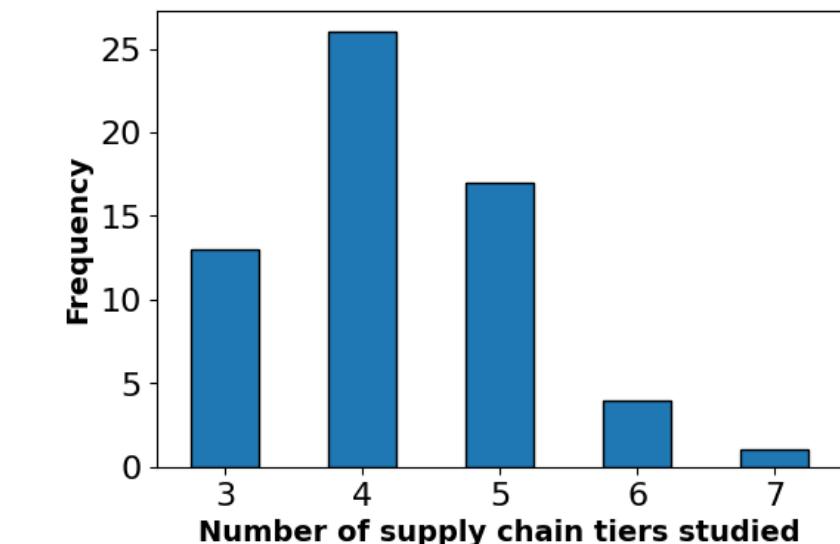
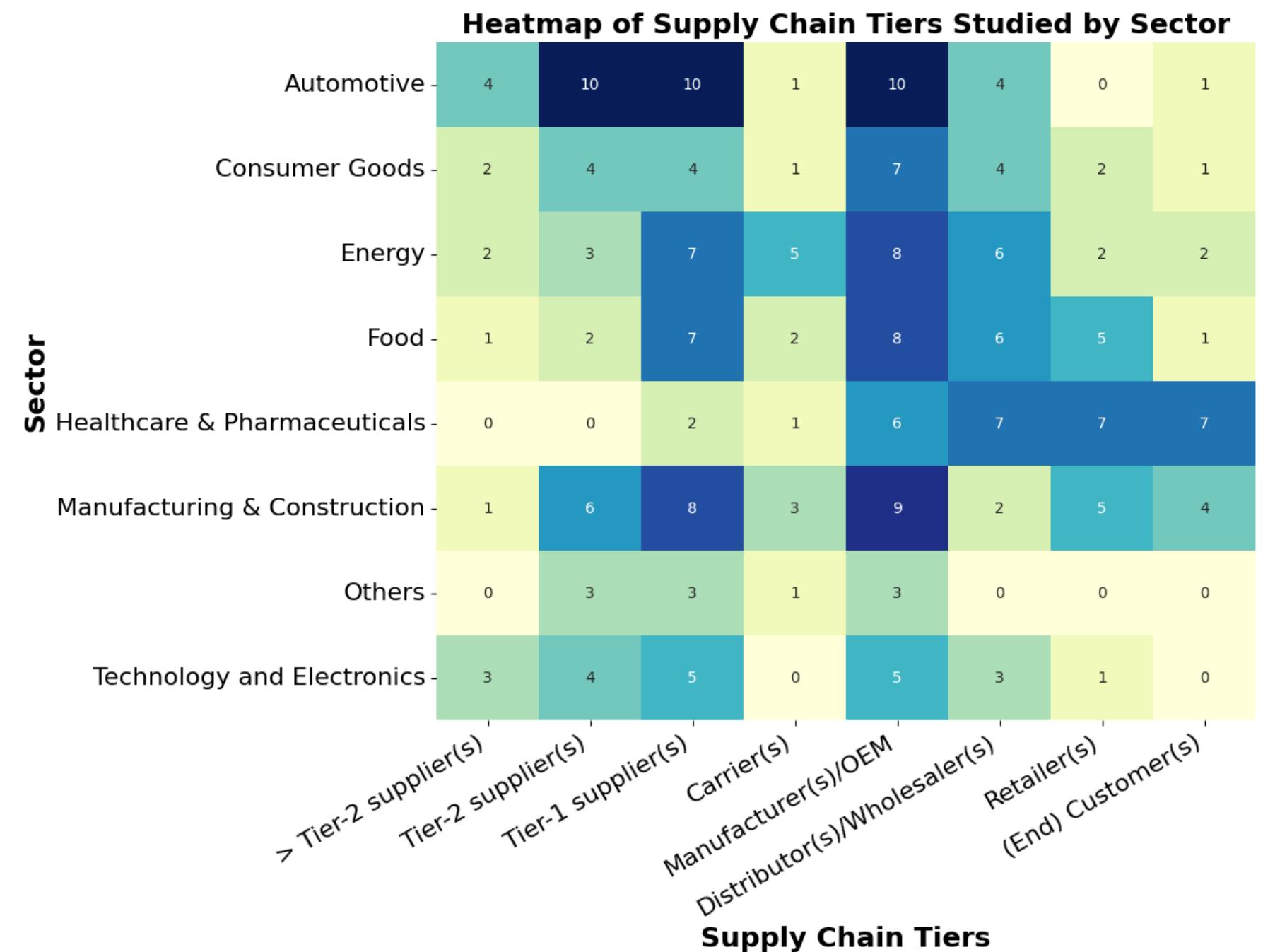


Research stresses multi-tier SCs to improve efficiency and select the best operational strategies

practices and policies that aim to reduce the environmental impact of supply chain activities; mainly apply the case study method, which could involve addressing industry-specific challenges

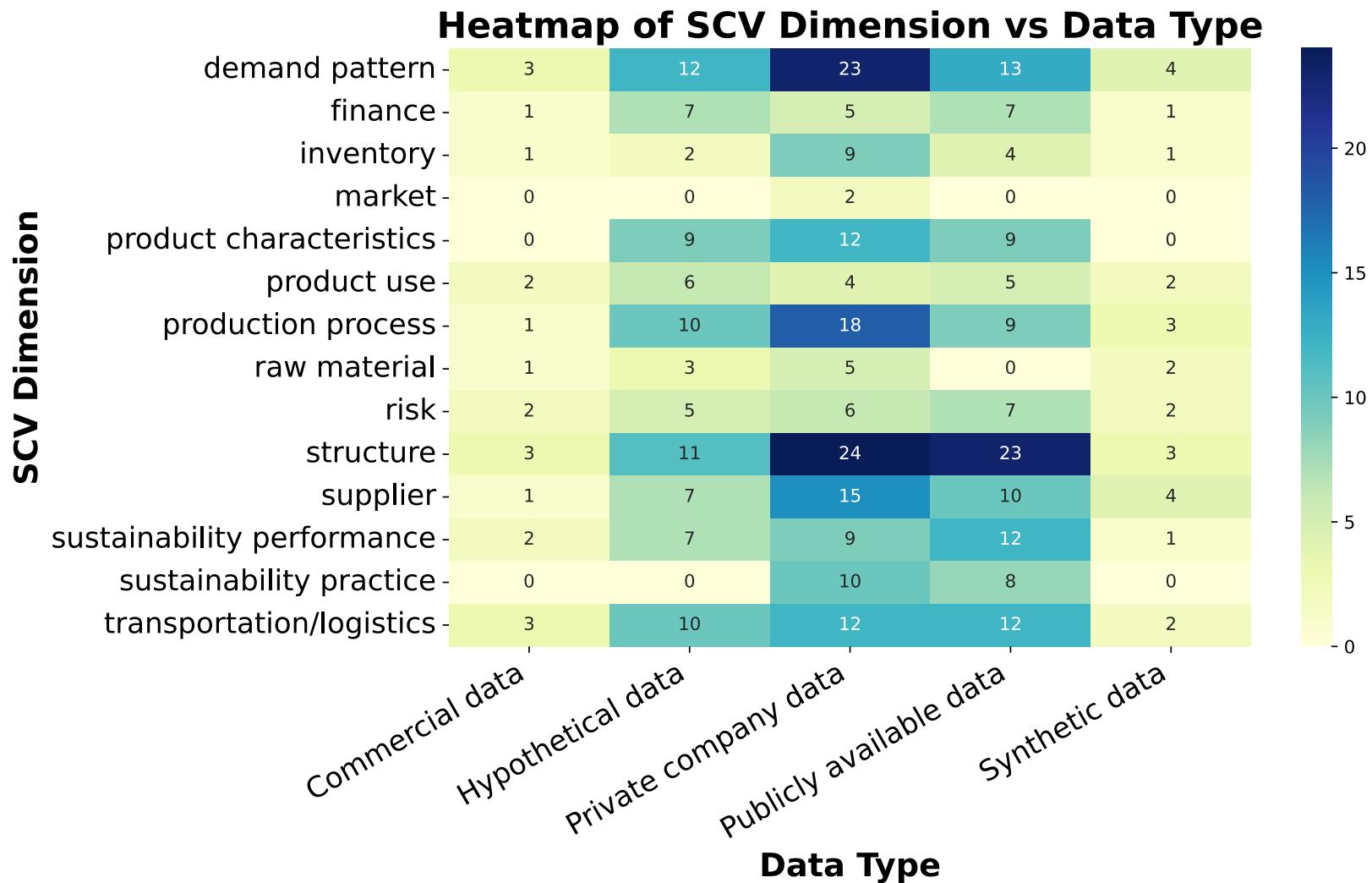
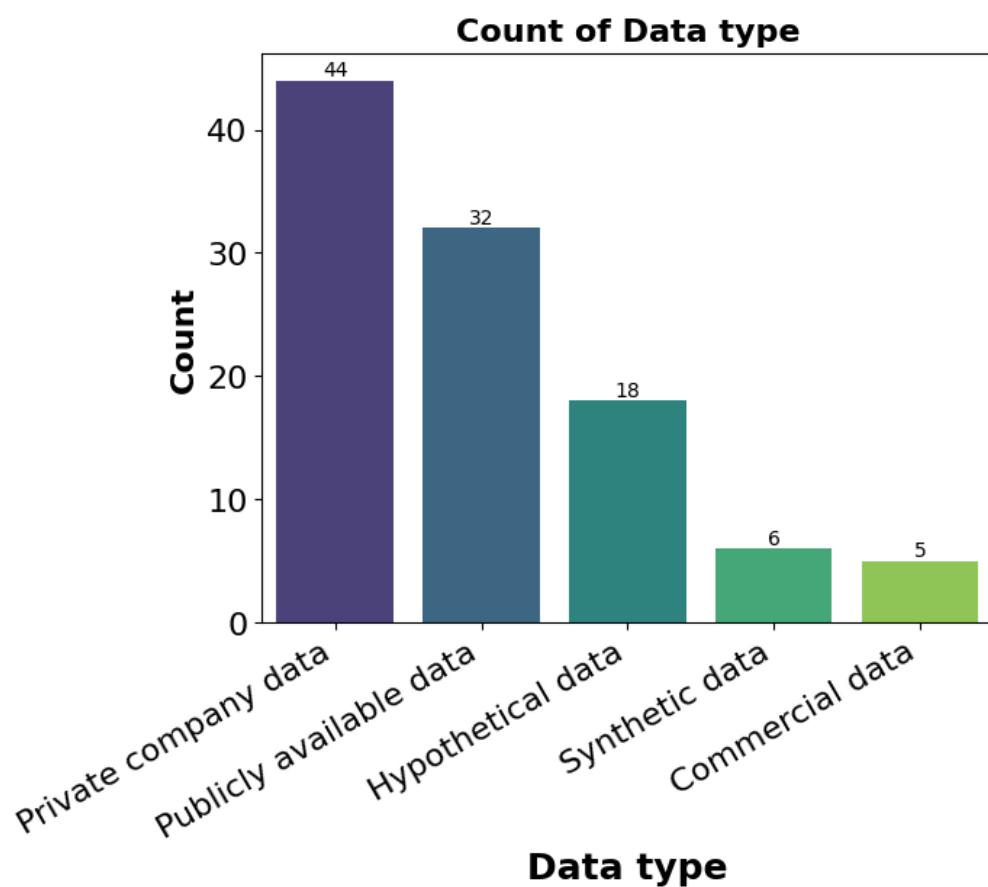
Sustainability, Environmental and Social Responsibility

Findings (2) – Supply Chain Structure Studied



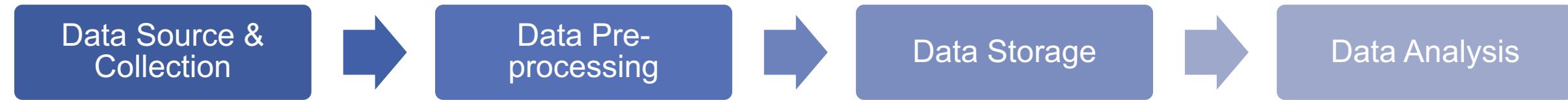
- Most studies focused on midstream supply chains (Manufacturers and their direct suppliers / customers)
- Tier-end supply chains are less studied (especially beyond tier-2 suppliers)
- End-to-end supply chain studies are very limited
- Automotive, Manufacturing & Construction focus heavily on **upstream** processes
- Healthcare & Pharmaceuticals place significant emphasis on the **downstream** stages

Findings (3) – Data types



- Half of existing research employed a mixture of data types
- existing research predominantly relies on private and public data, artificial data (hypothetical and synthetic data) often serves as a supplement, especially in situations where collecting real data is challenging
- Mostly studied supply chain visibility dimensions: demand pattern and structure → mainly collected from private company sources
- Dimensions concerning product-level information were less frequently investigated → the lack of product-level SC studies in existing research landscape

Findings (2) – Key observations of data exploitation processes



Quantitative Research (72%, 44 papers in total)	<ul style="list-style-type: none">Collected from public data sources (70%)Generated based on pre-defined assumptions (52%)Directly collected from involved (case) companies (50%)Purchased from commercial data providers (11%)Generated to follow real-life trends (9%)	<ul style="list-style-type: none">No validation (95%)Expert validation (5%, 2 papers only)	<ul style="list-style-type: none">Ad-hoc use (91%)Developed a database for research data storage (7%)	<ul style="list-style-type: none">Mathematical modelling (Mixed integer programming, Nonlinear programming)Simulation modelling (Discrete-event simulation, System dynamics)Machine learning (Decision tree, Deep learning, NLP)Statistical methods (Time-series forecasting)
Qualitative Research (26%, 16 papers in total)	<ul style="list-style-type: none">Conducted interviews (100%)Field visit (56%)Collected from public data sources (50%)Directly collected from involved (case) companies (50%)	<ul style="list-style-type: none">Triangulated the data through multiple data sources (e.g., interview data, field visits, secondary documents) (56%)No validation (13%)Validated through conducting a workshop (6%)Expert validation (6%)	<ul style="list-style-type: none">Ad-hoc use (69%)Developed a database for research data storage (31%)	<ul style="list-style-type: none">Qualitative case study (single case study, multiple case study, Within-case analysis, Cross-case analysis)

Findings (2) – Key observations of data exploitation processes



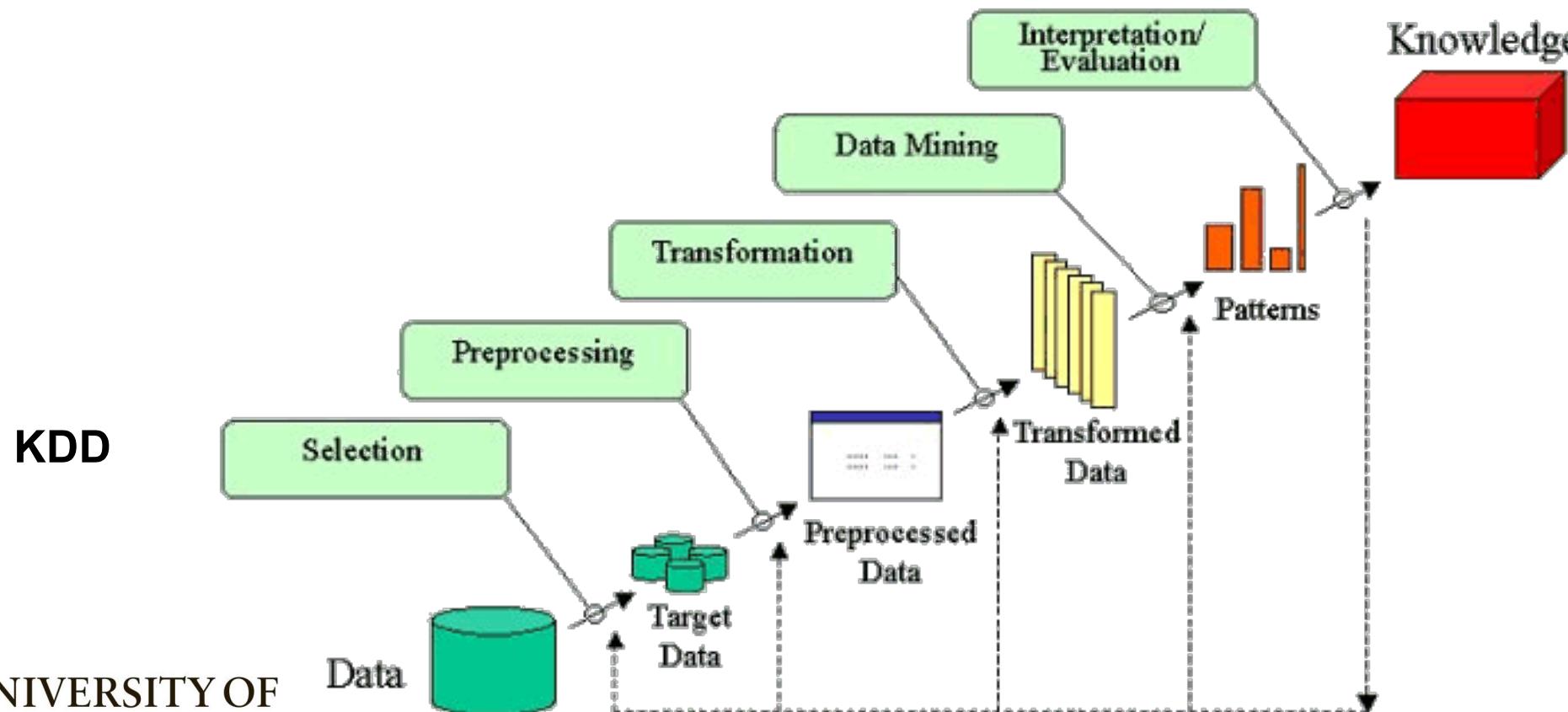
- Most studies used a mixture of various data types
- Qualitative research tends to have more standardised data methodology (e.g., Yin, 2009)
- Publicly available data is mainly sourced from public institutions (e.g., Government statistics department)
- Only 2 out of 61 papers specifically mentioned data source selection reasons
- Qualitative research mostly follows a certain methodology to conduct data triangulation and integration from multiple sources
- No methodology has been followed by quantitative research
- Most research used data for ad-hoc analysis
- Details of data storage were not exemplified
- Various methods have been adopted by quantitative research for different purposes
- Qualitative research methods are more consistent
- Most quantitative studies are related to supply chain optimisation
- Methods were selected to fit various design purposes

Challenges/Gaps:

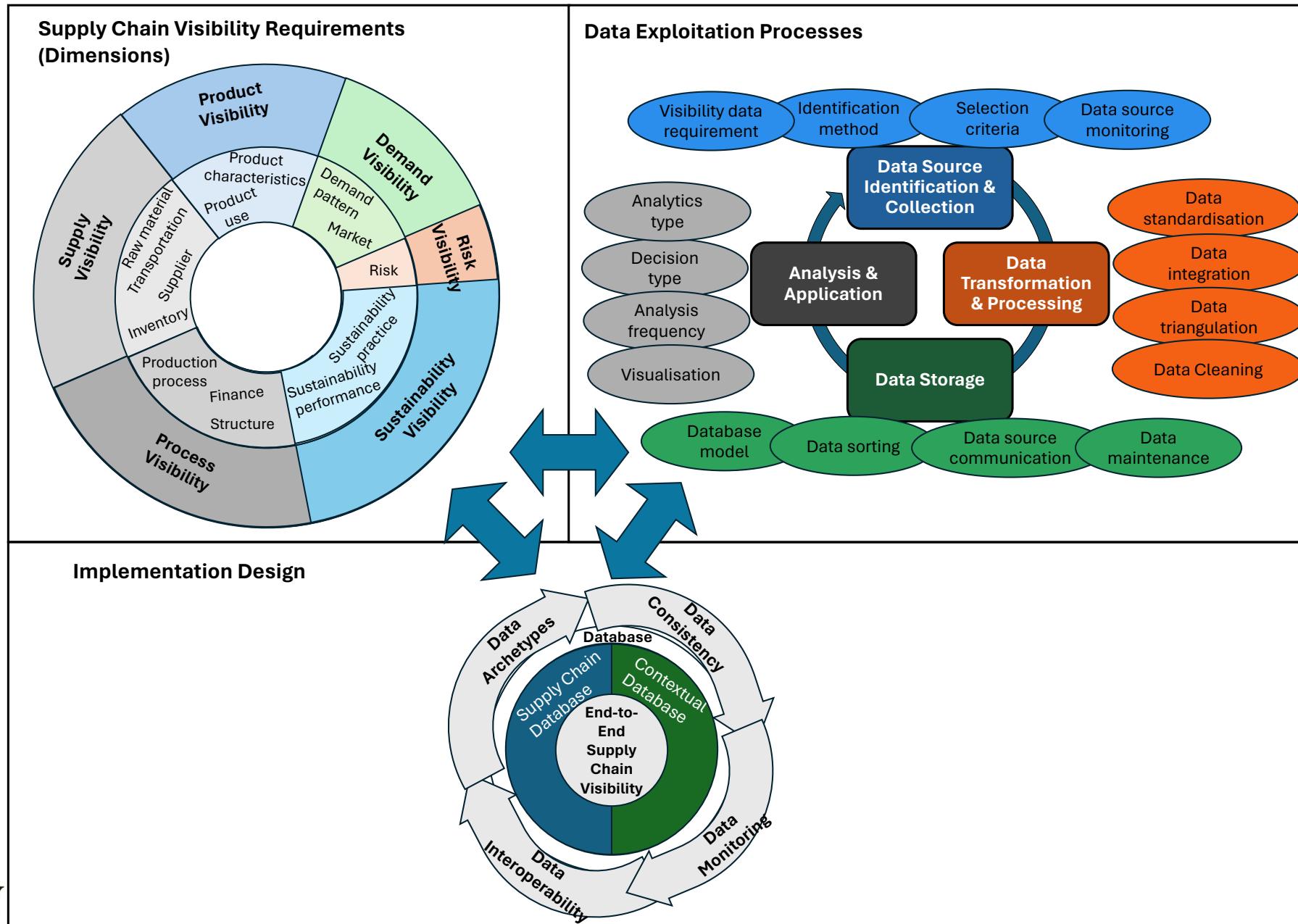
- Data exploitation process is **context-dependent**
- Lack of **systematic** data approach
- Multiple variables involved but lack of standardised **supply chain data archetypes**
- **Data availability and accessibility challenges**

Discussion – Future Research Directions

- Develop a standardised supply chain data archetype
- Better data usage and management through employing data management / analytics methodology such as Knowledge Discovery in Database (KDD) for quantitative research
- Expand supply chain visibility dimensions (e.g., product-level, market environment) and investigate product-level supply chains



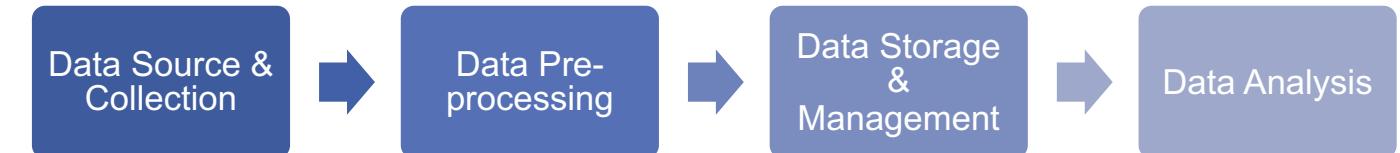
Discussion – Data Exploitation Guidelines



Conclusions

Objective 1: Identify existing publicly available data that can be linked to SCVTT

Objective 2: Understand the exploitation of data for developing visibility into multi-tier supply chains

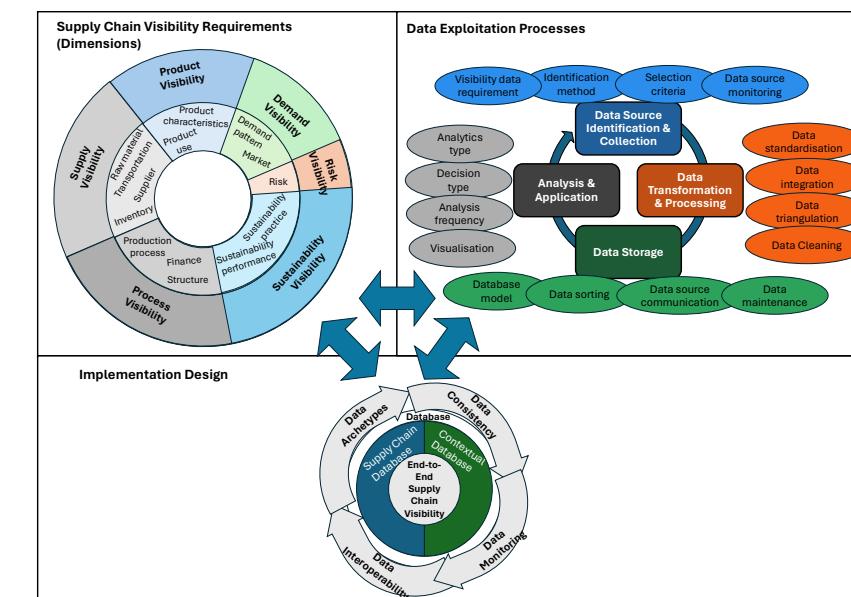


Methods and challenges

Contributions

- Provide a holistic view of the use of data in current supply chain research for developing visibility
- Identify theory gaps in the area and propose a guidelines for practical data exploitation processes

What's Next



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**Thank you!
Any questions or comments are welcome**

