

# Analytics and AI tools to transform supply chain decision-making

*A Data-X Seminar  
Macquarie University*

Ben Fahimnia, PhD  
Professor and Discipline Chair  
The University of Sydney



# YOUR SPEAKER

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- › Background
- › Research Focus and Expertise
- › Industry Engagement
- › SCLAA Directorship



# ANALYTICS IN SUPPLY CHAIN OPTIMISATION

- Typical challenges in supply chain optimisation
  - Scale and complexity of supply chain design/planning
  - Nonlinearity of objective functions and/or constraints
- Heuristic methods
  - Neural Networks, Genetic Algorithms, Reinforcement Learning

amazon



Australia Post

DHL

TOLL



HONDA

# ANALYTICS IN DEMAND PLANNING

- Traditional methods (e.g., moving average and smoothing methods) use only historical sales data.
- Machine learning takes demand planning to the next level using historical data as well as real-time data from various sources such as demographics, weather, online reviews, and social media.
- Results: reduced lost sales by 60%, reduced supply chain costs by 40%.



CALTEX



GWF / George Weston  
Foods Limited



# ANALYTICS IN BEHAVIOURAL DECISIONS

## › Discrete Choice Experiments

- Understanding how trade-off decisions are made (considering personality traits, social values/preferences, and risk-taking attitude) to inform the development of decision tools.

## › Lab/Field Experiments

- Identifying the hidden biases/anchors in supply chain decision making to inform the development of adaptive support systems.



**COTY**  
SINCE 1904



**Kimberly-Clark**

*Coca-Cola*

# CURRENT PROJECT

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## Customisable Decision Support Tools for Building Resilience in Essential Supply Chains

*Considering the risk attitude and risk mitigation priorities of each industry*



# SUPPLY CHAIN DISRUPTIONS

- Most supply chains in Australia rely on material/service supply from overseas.
  - **Wesfarmers Group** has over 3,000 suppliers in more than 40 countries.
- Disruptions in any part of the supply chain can result in supply shortage, lost sales, reputational damage, and even business closure.
- The unpreparedness of our supply chains:
  - Only 2% of companies were fully prepared for the pandemic, and over 70% reported serious negative impacts during the first year.

# RISK TYPES

## EXTERNAL RISKS

Not easy to mitigate because they are not within the business control.  
External events such as pandemics, natural disasters, or a trade war.

- Disruptions vs Interruptions
- Internal vs External Risks



## INTERNAL RISKS

Easier to mitigate because they are within the business control.  
A quality failure can be mitigated by tighter process control.



# COMMON MITIGATION STRATEGIES

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- › Diversifying supply base
- › Building domestic capabilities
- › Stockpiling
- › Sustainable development investments



# WHAT IS THE CHALLENGE?

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- It is not economically viable to invest in all mitigation strategies because managing risks entails costs.
  - The risk of single-sourcing can be mitigated through supply diversification. But multi-sourcing comes with costs due to reduced quantity discount when buying from multiple suppliers, and the complexities of monitoring the performance of all suppliers.
- Systematic cost/benefit trade-offs is required to identify the most suitable mitigation strategies to capitalise on.

# RISK MITIGATION IN ESSENTIAL INDUSTRIES

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- Risk mitigation decisions must be made more carefully for Essential Goods and Services since their continued supply during disruptions plays a critical role in national economy and security, and the wellbeing of our people.
- The supply chains of these goods and services are the Essential Supply Chains that if disrupted can jeopardise the national economy and security.

# SYSTEMATIC RISK MITIGATION

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## STEP 1

Identify essential industries

# ESSENTIAL INDUSTRIES IDENTIFIED

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## ESSENTIAL GOODS & SERVICES

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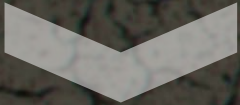
1. **Food and Grocery** (food supply, retail services)
2. **Health** (health care, pharmaceuticals, residential care, social assistance)
3. **Finance** (banking, financial services)
4. **Energy** (electricity, gas, petroleum services)
5. **Water** (water supply, bottling, drainage services)
6. **Logistics** (passenger/freight transport, warehousing, import/export services)
7. **Communications** (broadcasting, internet, telecommunication services)
8. **Government** (defence, regulatory and public administration services)

# SYSTEMATIC RISK MITIGATION

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## STEP 1

Identify essential industries



## STEP 2

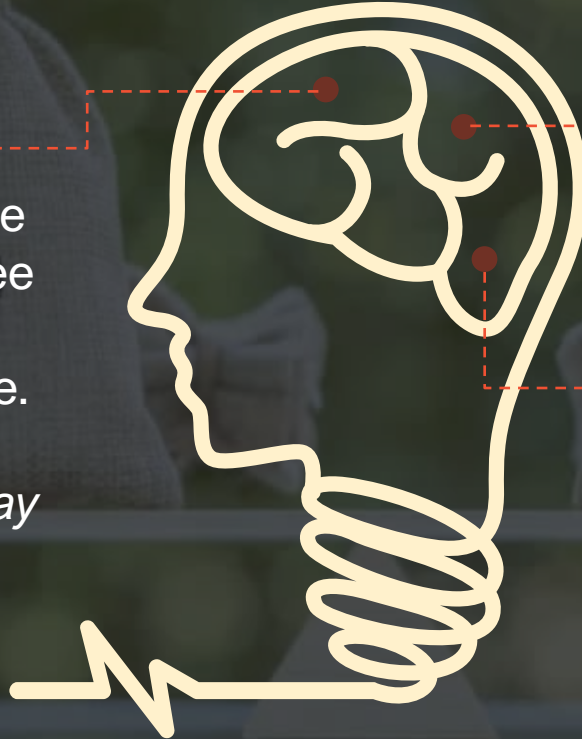
Understand the **risk attitude** of each industry

# RISK APPETITE, TOLERANCES, THRESHOLDS (RATT)

How experts make risk trade-off decisions in each industry

## RISK APPETITE

- The high-level subjective description of the degree of risk (qualitative) an industry is willing to take.
- Measuring the hunger.
- *Overall willingness to pay for resilience*



## RISK TOLERANCES

- Quantify the risk attitude (% or amount of the risks an industry can withstand)
- *Willingness to pay for different mitigation strategies*

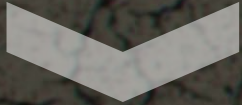
## RISK THRESHOLDS

- The level beyond which a risk is not tolerated, considering the probability of occurrence and the level of impact.

# SYSTEMATIC RISK MITIGATION

## STEP 1

Identify essential industries



## STEP 2

Understand **risk appetite**, **risk tolerance**, and **risk threshold** of each industry



## STEP 3

Develop a **practical framework** that classifies and precisely explains the risk attitude and mitigation priorities of each of industry



## STEP 4

Develop **decision tools** using the framework in Step 3 and operational data to generate customised risk mitigation prescriptions



# ANALYTICAL MODELS AND DECISION TOOLS

- Using the framework in Step 3 (risk attitude and priorities) + operational data from each industry, develop and assess risk mitigation scenarios to determine the optimal combination of mitigation strategies for each industry (customised prescriptions).
  - **Stochastic dynamic programming methods** (Markov Decision Processes MDPs) to account for supply chain dynamics (variations in demand/supply, capacity changes), and disruption dynamics (probability of disruption occurrence, level of impact, recovery time).
  - **Reinforcement learning methods** to deal with large operational data and identify optimal risk mitigation scenarios from thousands of alternatives.

# APPLICATIONS OF MITIGATION PRESCRIPTIONS

## RESILIENT ESSENTIAL SUPPLY CHAINS

Systematic risk assessment to help our essential industries design more resilient supply chains minimising the impact of future disruptions

## INFORMED POLICY DECISIONS

Provide insights for informed federal and state policy decisions to support our essential industries (e.g., by offering financial incentives, providing critical information about risks, or taking direct ownership of the risk management of certain products/services)

