Accenture - MIT Capstone Project

Empowering Supply Chain through

AI Driven Supplier Indexing and Recommendation

Motivation: the Empty Shelf Problem
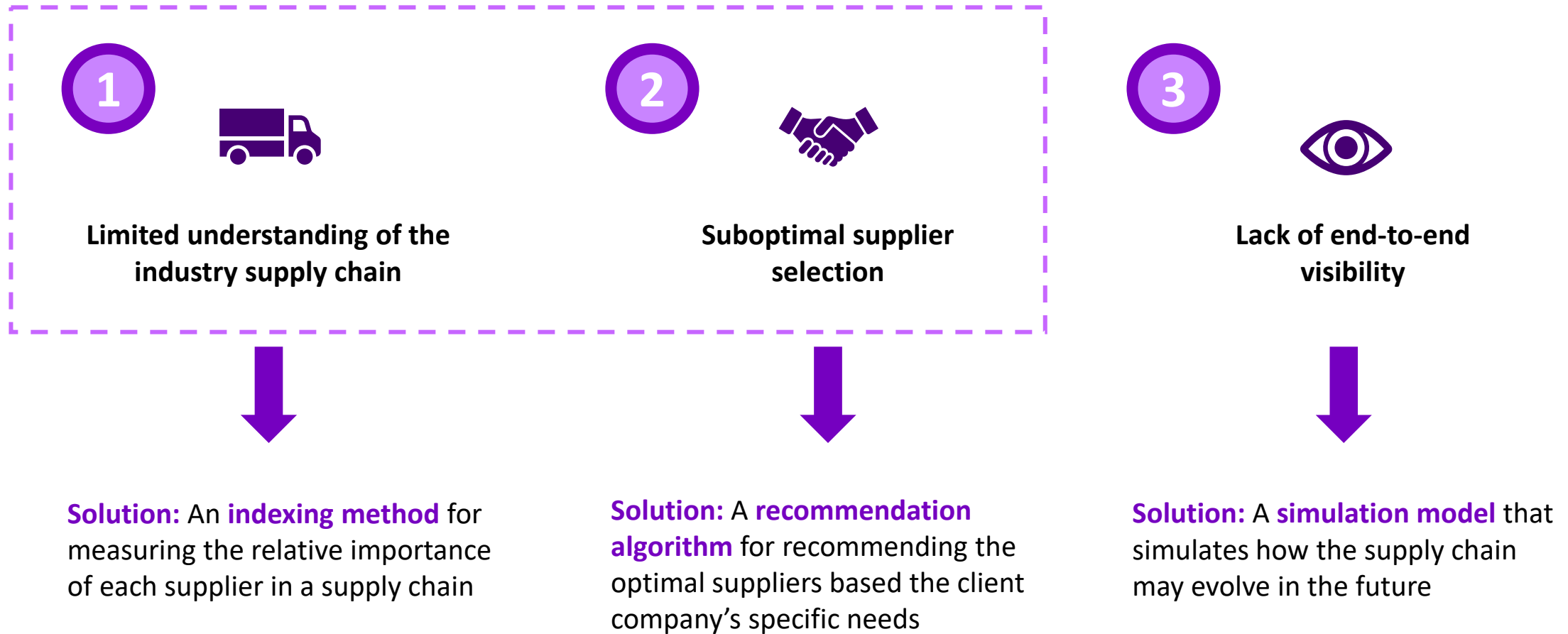

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24 June 2022

War in Ukraine drives global food crisis

Reports   Conflicts

A global food crisis fuelled by conflict, climate shocks and the COVID-19 pandemic is growing because of the ripple effects of the war in Ukraine driving rising prices of food, fuel and fertilizer. Millions of people across the world are at risk of being driven into starvation unless action is taken now to respond together and at scale. Due to the unprecedented overlap of crises, WFP's annual operational requirements are at an all-time high of US$22.2 billion, with confirmed contributions so far at US$4.8 billion (22 percent). WFP is calling for coordinated action to address this crisis.

WAR IN

Behind the Empty Shelf: A Vulnerable Supply Chain

Our project focuses on tackling the first two problems, and the 3rd problem will continue to be explored by Accenture in the future.

1	**2**	**3**
Limited understanding of the industry supply chain	**Suboptimal supplier selection**	**Lack of end-to-end visibility**

Solution: An **indexing method** for measuring the relative importance of each supplier in a supply chain

Solution: A **recommendation algorithm** for recommending the optimal suppliers based the client company's specific needs

Solution: A **simulation model** that simulates how the supply chain may evolve in the future

Dataset Overview

- **FactSet Supply Chain Relationships Dataset**
  - Contains pairwise supplier-customer relationships info

- **FactSet Relevance Rank Dataset**
  - Contains the grade and ranking that FactSet assigns to the supplier/customer in each customer-supplier relationship

- **Arabesque Dataset**
  - Contains company-level sustainability info covering aspects like emission, diversity, and human rights

Pilot Industry: Mining and Mineral

Suppliers to Companies in Mining and Mineral → Companies in Metals and Mining

4065* Reported Relationships

538 Unique Companies

2052 Unique Suppliers

74 Unique Countries

* Numbers displayed are from the cleaned dataset used to train the RecSys in Phase 2. The numbers may differ for the indexing creation stage as we used slightly different filtering requirements.

Phase 1: Supplier Indexing

Objective: Obtain a relative importance score for each supplier in the entire industry's supply chain.

Obtain Raw Metrics	Metric Normalization	Node-level Aggregation	Non-linear Transformation	Index Normalization
1. Uniqueness 2. Ranking 3. Centrality Measures	Normalize each metric to a scale of 0 to 100 so that no single metric can dominate the overall score	Obtain a single indexing score from weighted average of all metrics	Emphasize or de-emphasize the variation in node-level indexing scores if necessary	Normalize the node-level scores to a scale of 0 to 100 for better interpretability

Supplier Indexing Results

Below are the suppliers with the TOP 10 highest overall importance scores in **Mining and Mineral:**

Sand-Storm Gold Ltd. (92)

KCP Ltd. (76)

Pennar Industries Ltd. (98)

Franco- Nevada Corp (100)

TOCALO CO., Ltd. (84)

Prism Johnson (73)

ArcelorMittal SA (84)

POSCO. (74)

ALROSA PJSC (63)

Assa Albloy AB (85)
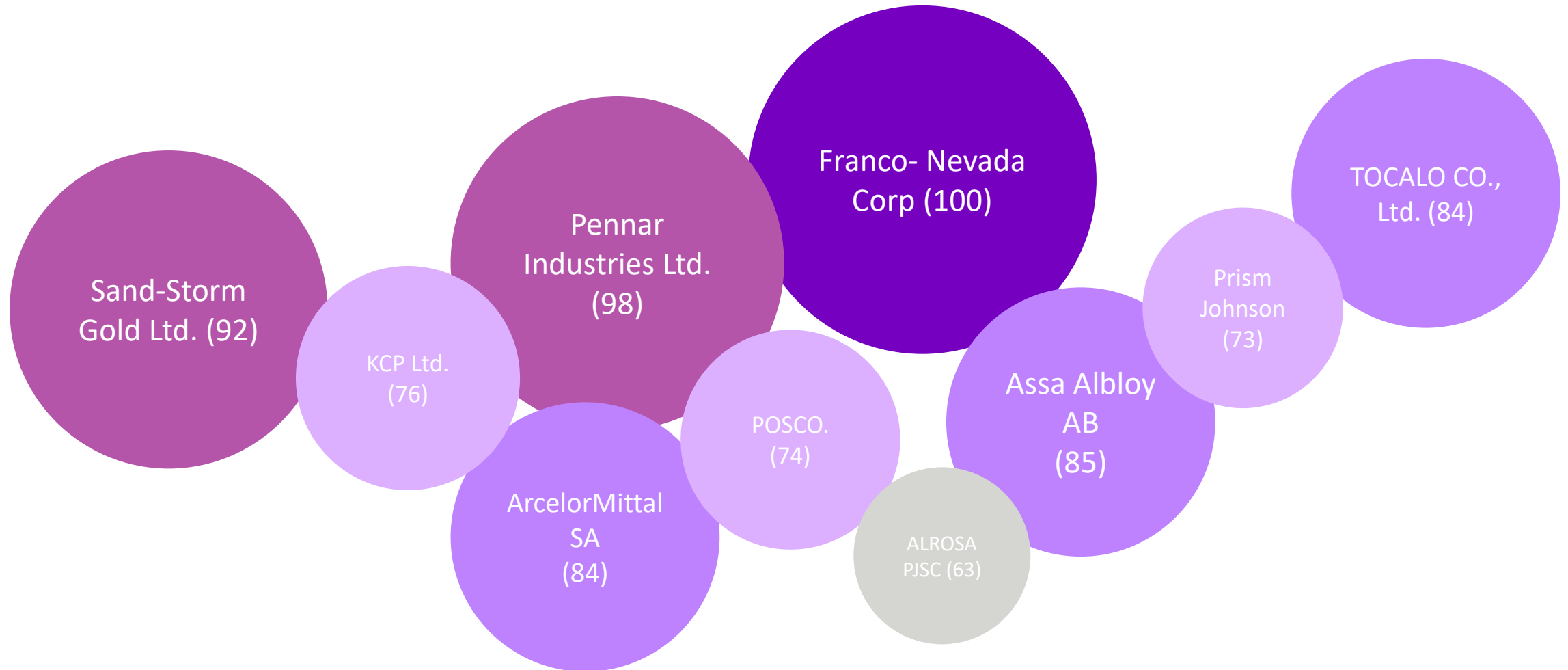
# Phase 2: Supplier Recommendation

Objective: Recommend high-quality suppliers for the client company based on industry patterns and client-specific needs

- Inspiration: Movie recommendation
  - Recommend movies to users based on users' rating history
  - Ex. *"People like you have also watched…"*

- Main Challenge: No Explicit Ratings
  - Need to create an index that is representative of a company's rating for a particular partnership

	$Supplier_1$	$Supplier_2$	$Supplier_3$	$Supplier_4$
$Comp_1$	3	?	9	?
$Comp_2$	7	8	1	9
$Comp_3$	⬆ (green)	9	⬇ (red)	10
$Comp_4$	?	?	2	3

It's very likely that company 3 will give high rating for supplier 1 and low rating to supplier 3 given its similarity with company 2.

Phase 2: Supplier Recommendation (Cont'd)
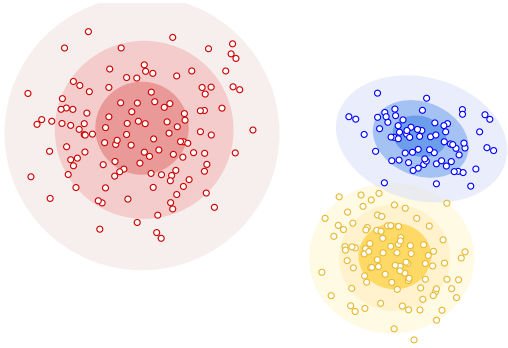
Company Segmentation

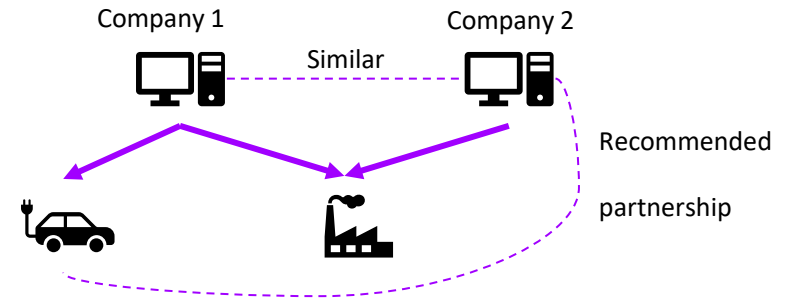We want to understand the strategic behavior across companies and identify those sharing common behaviors.

- **Macro-level info**

- **Supply chain network**

- **Company-specific partnerships**

Rating Construction

Company-supplier rating can be computed for each cluster using the following data.

- **Supplier-specific info**

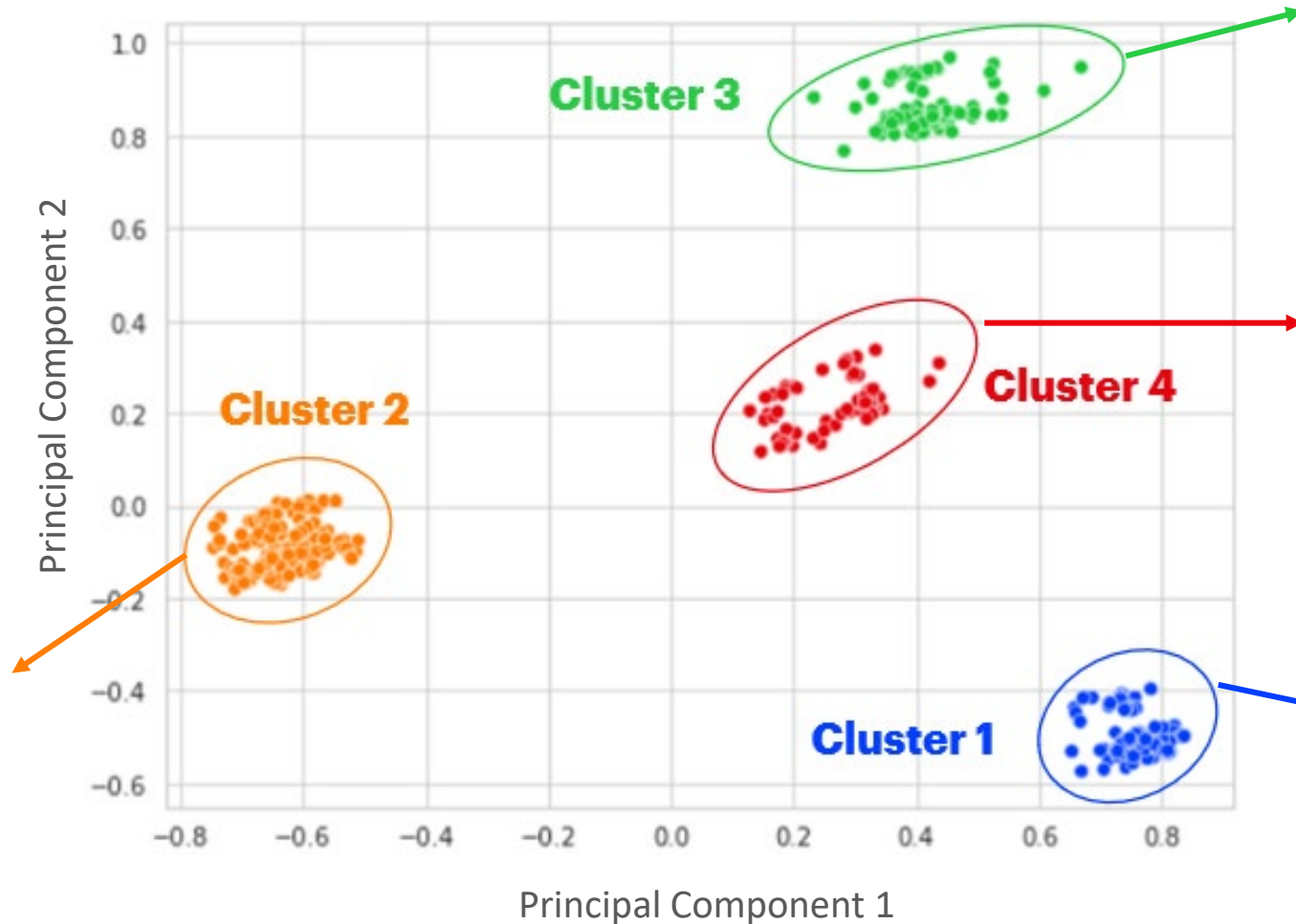- **Trust in partnership**

- **Strategic behaviors**

Recommendation Algorithm

We use the ratings constructed in step 2 to train a **recommendation model** via SVD++.

For each company of interest, we can identify the best supplier(s). End-users can **customize their recommendation results on a Web-App**.

Company Segmentation Results for the Mining and Mineral Industry

- **Mostly located in Europe**
- **High GDP per capita**
- **Lots of suppliers**

- **Mostly located in Oceania/South America**
- **Medium GDP per capita**
- **Lots of suppliers**

- **Mostly located in Asia**
- **Low GDP per capita**
- **Few suppliers**

- **Mostly located in North America**
- **High GDP per capita**
- **Not so many suppliers**

Supplier Recommendation Results

- The recommendation algorithm recommends the best set of potential suppliers

- In addition, the client can customize the recommendation results to better reflect their needs via our Web Interface

I want to identify the **TOP 5** suppliers that are in **Mining and Mineral** and have **sustainability scores above 50** in **Canada**

| Number of Recommendations needed: | 5 | Sustainability Cutoff: | 50 |

Canada ✕ ▼

Mining and Mineral Products ✕ ▼

supplier_id	supplier_name	supplier_country	supplier_industry	supplier_sustainability	rating	rounded_rating
06LBVF-E	Lundin Mining Corp.	Canada	Mining and Mineral Products	61.45	6.08	6
06LTWP-E	First Majestic Silver Corp.	Canada	Mining and Mineral Products	73.98	5.57	6
001Y5Z-E	Pan American Silver Corp.	Canada	Mining and Mineral Products	64.67	5.33	5
003P6F-E	Yamana Gold, Inc.	Canada	Mining and Mineral Products	70.37	4.98	5
05DZGZ-E	Barrick Gold Corp.	Canada	Mining and Mineral Products	65.62	4.95	5

Screenshot of the Web Interface output of the query on the left

Business Impact

21.4% improvement in RMSE compared to the baseline

Expected to **save over 21,000 work hours** if applied to all companies in Mining and Mineral
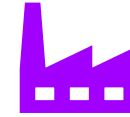
Customizable recommendation results from Web Interface

Our pipeline is **highly adaptable** because the same pipeline can be easily adapted to other industries

Why is this important?

Client Company

- Reduced costs in supplier selection
- Improved supplier quality

General Consumers

- Improved supply chain reliability
- Fewer empty shelf problems

Potential Directions for Future Work

Short Term:

☑ Expand drivers in previous analysis

Examples of additional data soures: financial metrics, news articles, alternative sustainability measures (S&P ESG)

☑ Refine interactive user interface

More filtering options, real-time computation

Long Term:

☑ Explore simulation techniques

Potential techniques: Monte Carlo, Agent-Based, Digital Twin

Thank you