3RINCs 2025 The 3R International Scientific Conference on Material Cycles and Waste Management

Ministry of Foreign Affairs
Republic of Korea

Building consensus for a global plastic treaty: Key implications from Busan INC-5

Empirical Insights from LLM-Based Sentiment Analysis of INC-5 Negotiations

Tongkyu Kim I tkkim24@mofa.go.kr

1.1. Contextual Background: Timeline of Global Plastics Treaty Negotiations

The **Intergovernmental Negotiating Committee (INC)** is an UN-mandated body tasked with developing a **legally binding international treaty to end plastic pollution**, covering the full plastic lifecycle—from production to disposal—by building consensus among **member states through a multi-session negotiation process**.

2022.03 UNEA-5.2

UNEA-5.2 (Nairobi, Kenya)

Resolution 5/14 adopted by 175 countries.

Formally launched the INC process to develop a legally binding instrument to end plastic pollution by the end of 2024

2022.11~2024..04 INC-1~4

INC-1: Organizational Session (Punta del Este, Uruguay)

△Set rules of procedure △Early divisions over scope (lifecycle vs. waste) △Industry participation begins.

INC-2: Paris Procedural Dispute (Paris, France)

△ Procedural deadlock over voting vs. consensus. △ High Ambition Coalition calls for production limits. △ Lack of meaningful progress

INC-3: Zero Draft Introduced (Nairobi, Kenya)

△Zero Draft of treaty text presented. △Key fault lines: ①Upstream regulation, ②Bindingness, ③Equity, ④Finance, ⑤Industry influence.

INC-4: Consolidation Begins (Ottawa, Canada)

△Refine Zero Draft. △ No consensus was reached on binding commitments. △ Lack of meaningful progress

2024.11~ INC-5

INC-5 (Busan, Korea)

△Originally scheduled as the final negotiating session. △Failed to achieve agreement on six contentious agenda items. △Expected to conclude at INC-5.2

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1.2. Research Importance: Strategic Insights for INC-5.2

Due to **unresolved negotiations** at INC-5 in Busan, key treaty elements will be finalized at the resumed session, INC-5.2, scheduled for August 2025 in Geneva.

Support	6 Key (Unresolved) Agenda Items	Against
Targets the root cause of plastic pollution	Plastic Production Limits	Impacts petrochemical-dependent economies
Ensures accountability and enforceability	Legally Binding Force	Politically sensitive for sovereignty-minded states
Protects human health and ecosystems	Regulation of Hazardous Additives	Industry resistance due to reformulation costs
Addresses past damage and visible environmental impact	Obligations for Legacy Pollution	High costs; some developed countries view it as too burdensome
Ensures capacity-building and North-South equity	Financial and Technical Support	Donor fatigue or reluctance to commit new resources
Ensures public interest over private profit	Anti-Lobby Rules and Transparency Safeguards	Petro industry argues for "stakeholder inclusion"

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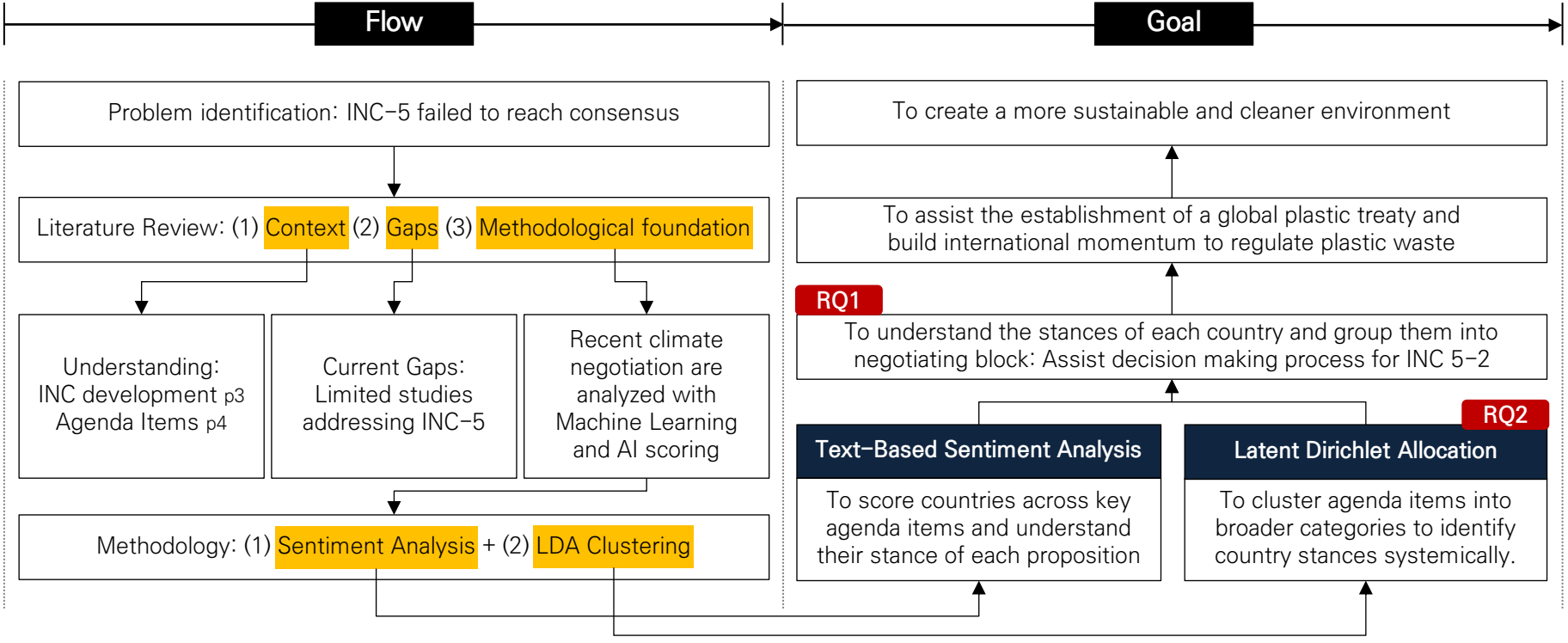
1.3. Research Question and Design: Flow of Study

(RQ1) How do countries differ in their negotiation positions on the global plastics treaty?

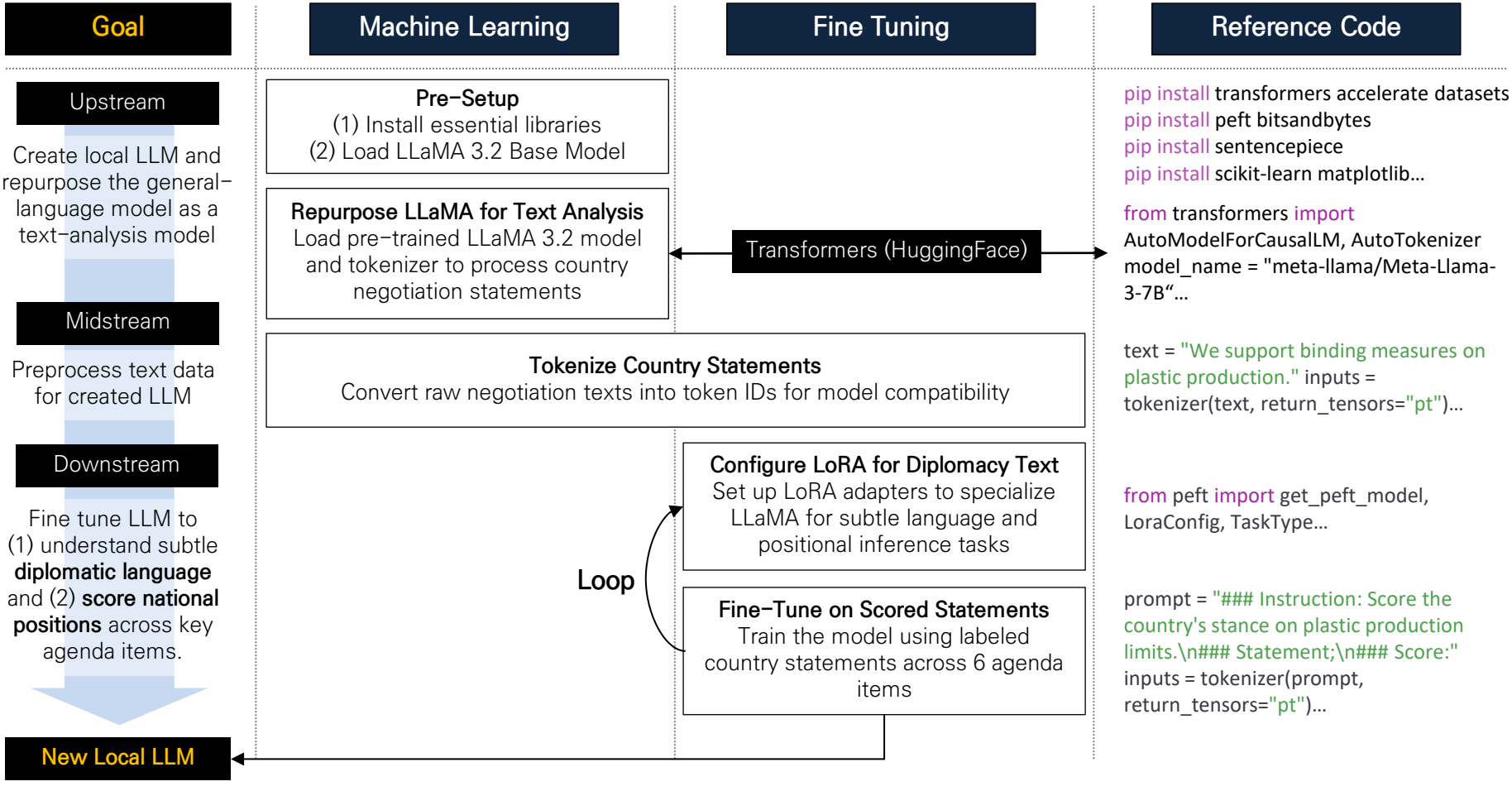
(RQ2) How can unresolved agenda items be grouped into a coherent typology that reveals underlying state preferences?



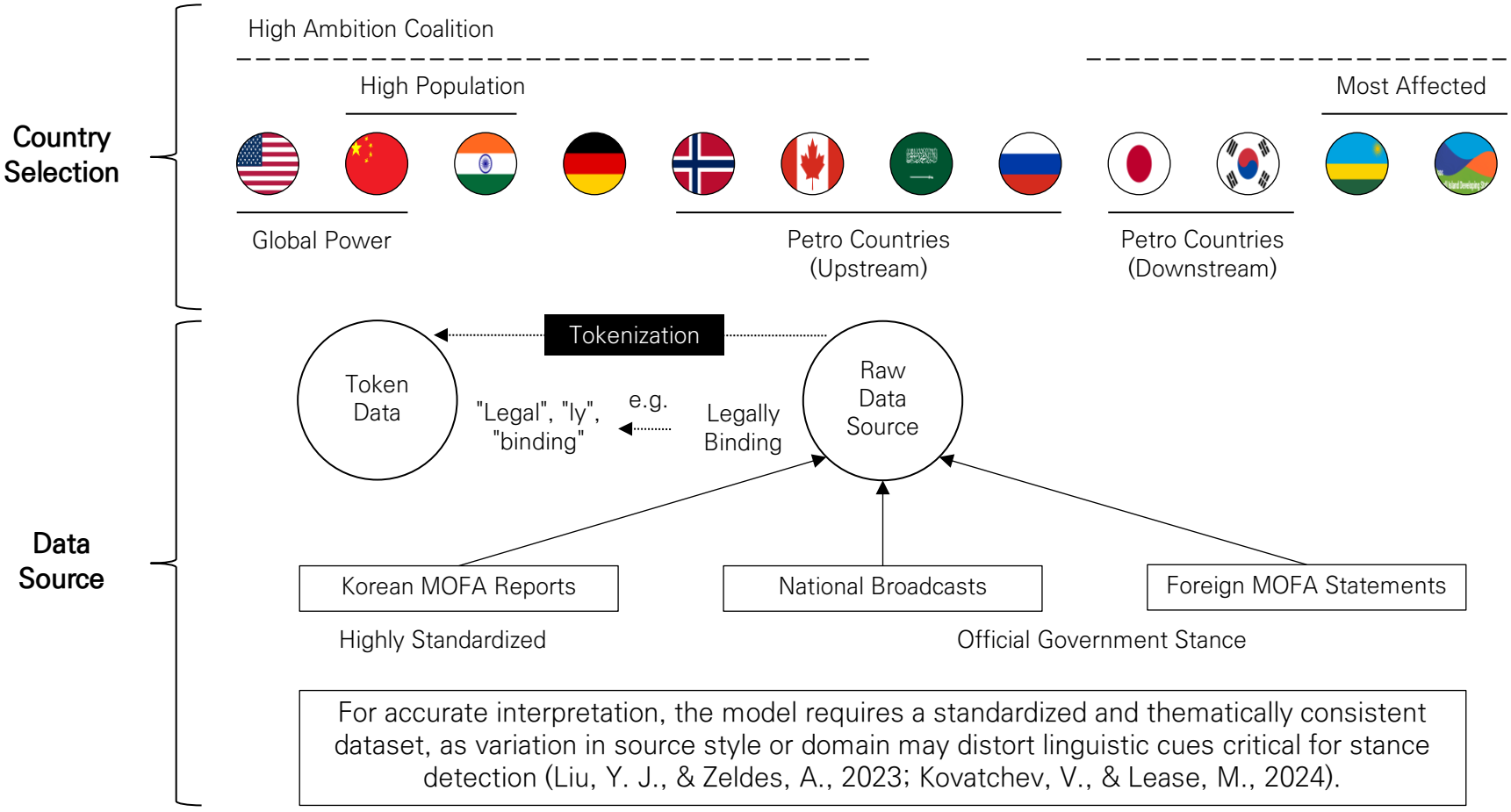
2.1. Literature Review: What we know and what is needed

	Literature	Existing Findings	Gap (Novelty)
Context: **Development of sustainability negotiations**	Stöfen-O'Brien, 2023; Weinger, 2023; Tiller, 2023; Strauss, 2013; Najam, 2003; Kasa, 2008; Barrett, 2016; Schroeder, 2012; Glachant, 2017	Summarizes historical development of climate negotiations, its linkage to plastic treaties, and basic stances of countries	**Lack of studies that address INC-5. Current literature is mainly conceptual, with limited empirical validation**
Plastic pollution: **Characteristics unique to plastic pollution**	MacArthur, 2017; Rigamonti et al., 2014; Faraca & Astrup, 2019; Liang et al., 2021; Siddiqui & Pandey, 2013; Wong et al., 2015; Rochman et al., 2013; Tiwari et al., 2023; Milbrandt et al., 2022	Existing studies on plastic pollution predominantly focus on environmental impacts, technical solutions, consumer behavior, life cycle assessments	**Most research on plastic policy is conducted at the local level, with limited consideration of countries' involvement in international treaty processes**
Methodology: **Use of sentiment analysis and component clustering**	Taherdoost & Madanchian, 2023; Patel et al., 2020; Krugmann & Hartmann, 2024; Aftab et al., 2021; Li et al., 2021; Tran-Nguyen et al., 2023; Wójcikowski et al., 2017	The development of AI position LLM as effective tools for interpreting and classifying concepts and sentiments within a defined typology	**Current lack of use of Machine Learning and Fine-Tuning Techniques for social sciences: Particularly for Global Plastic Treaty**

3.1. Methodology (1): Text-Based Sentiment Analysis Using Fine-Tuned Local LLM



3.2. Sample: Reference Countries and Data Source



3.3. Methodology (2): Latent Dirichlet Allocation (LDA) For Agenda Item Clustering

Latent Dirichlet Allocation (LDA) is an unsupervised machine learning algorithm used to discover hidden thematic structures ("topics") within a collection of text documents.

Tokenized Text → **LDA** → **Topic Clustering**

Assign Topics to Documents

```
for i, row in enumerate(lda_model[corpus]):
print(f"Document {i}: Topic Distribution: {row}")
```

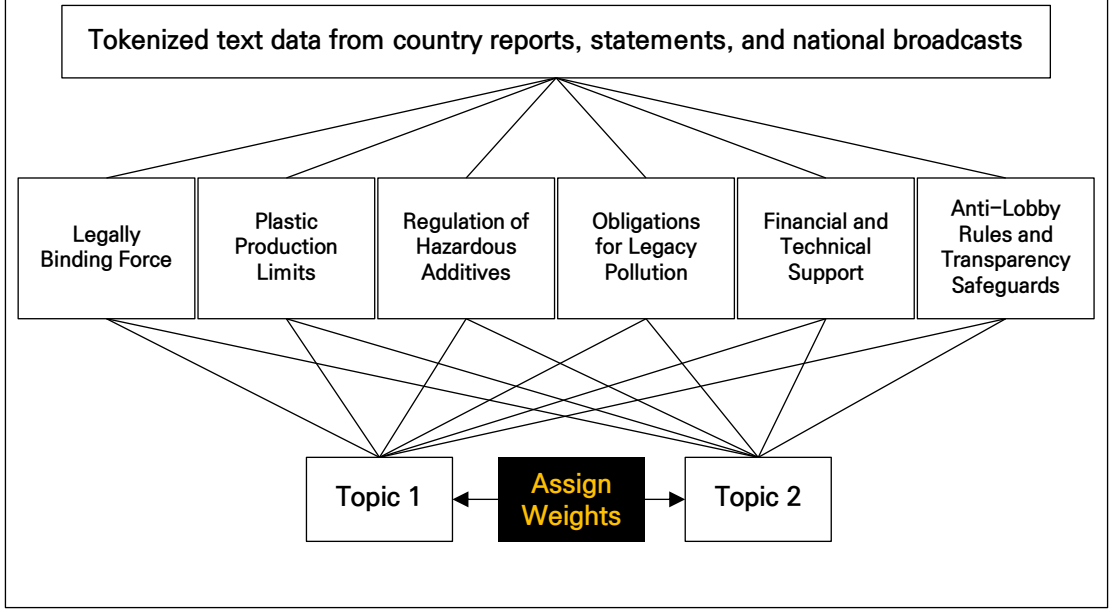
Explore the Topics

```
topics = lda_model.print_topics(num_words=6)
for i, topic in topics: print(f"Topic {i}: {topic}")
```

Create and Train LDA Model

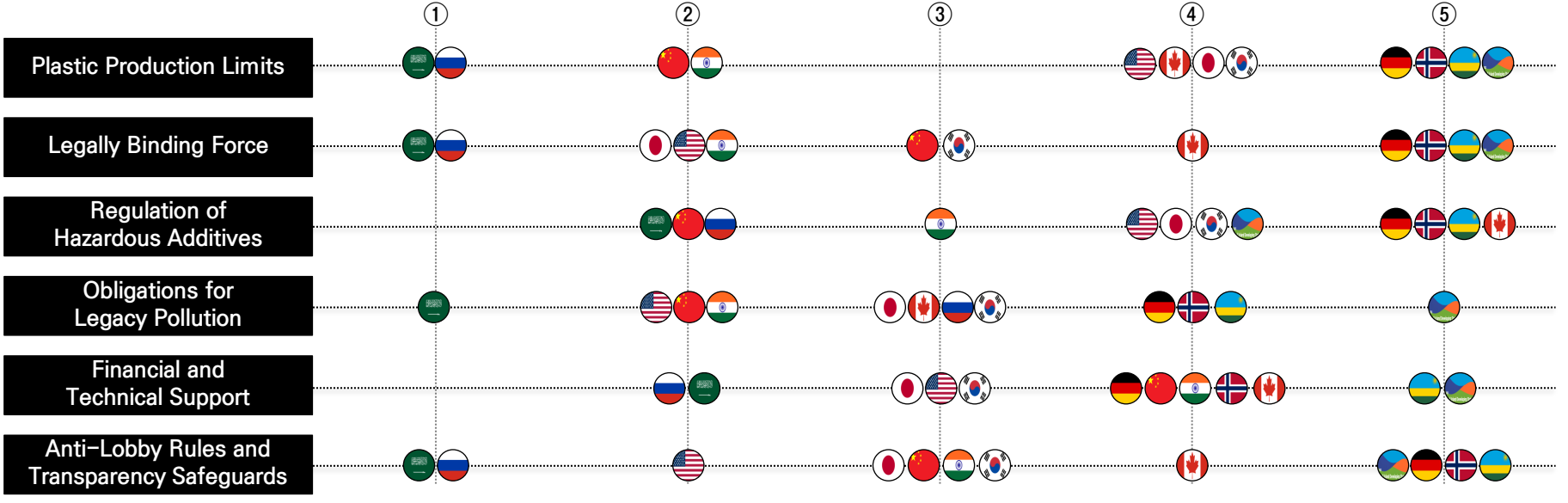
```
lda_m= gensim.models.LdaModel( corpus=corpus,
id2word=dictionary…
```

Python with Gensim



4.1. Sentiment Analysis Results: Stance of Each Country Across 6 Core Agenda Items

	USA	CHN	IND	DEU	NOR	RWA	CAN	SAU	RUS	JPN	ROK	SIDs
Plastic Production Limits	4	2	2	5	5	5	4	1	1	4	4	5
Legally Binding Force	2	3	2	5	5	5	4	1	1	2	3	5
Regulation of Hazardous Additives	4	3	3	5	5	5	5	2	2	4	4	4
Obligations for Legacy Pollution	2	2	2	4	4	4	3	1	3	3	3	5
Financial and Technical Support	3	4	4	4	4	5	4	2	2	3	3	5
Anti-Lobby Rules and Transparency Safeguards	2	3	3	5	5	5	4	1	1	3	3	5



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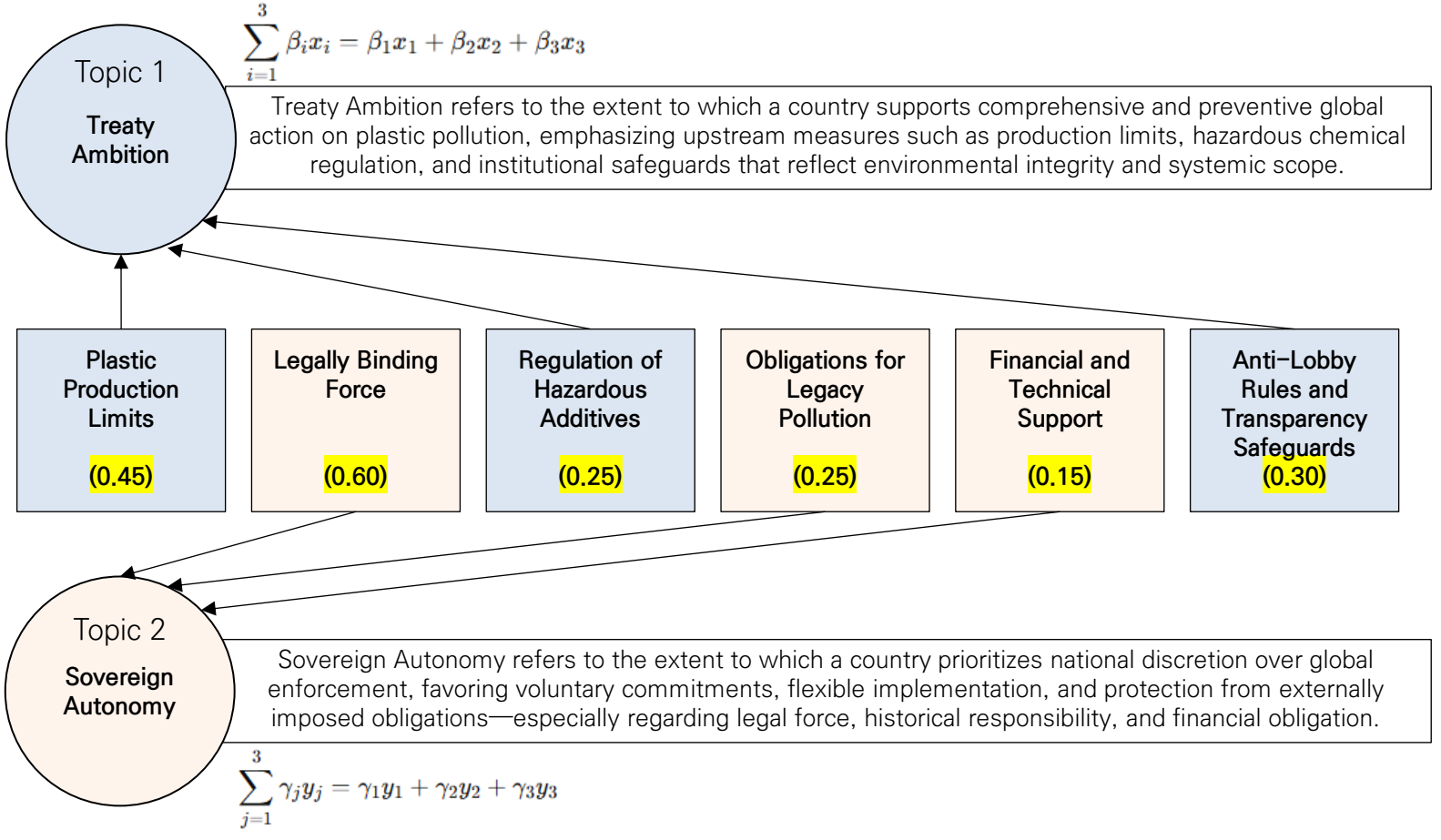
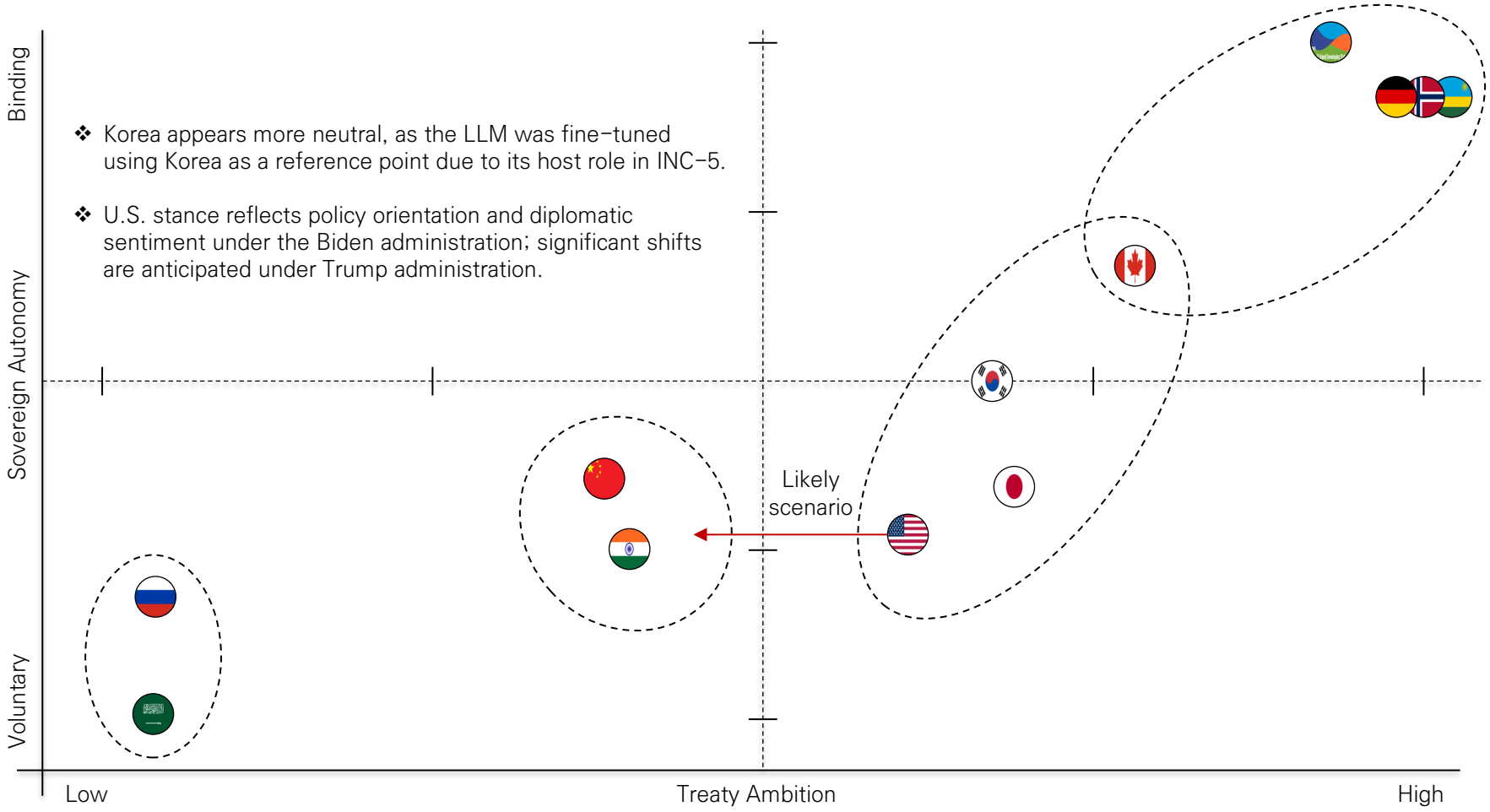
4.2. LDA Results: (1) Treaty Ambition (2) Sovereign Autonomy



4.3. Mapping National Preferences: Empirical Results from Fine-Tuned LLaMA Model Analysis



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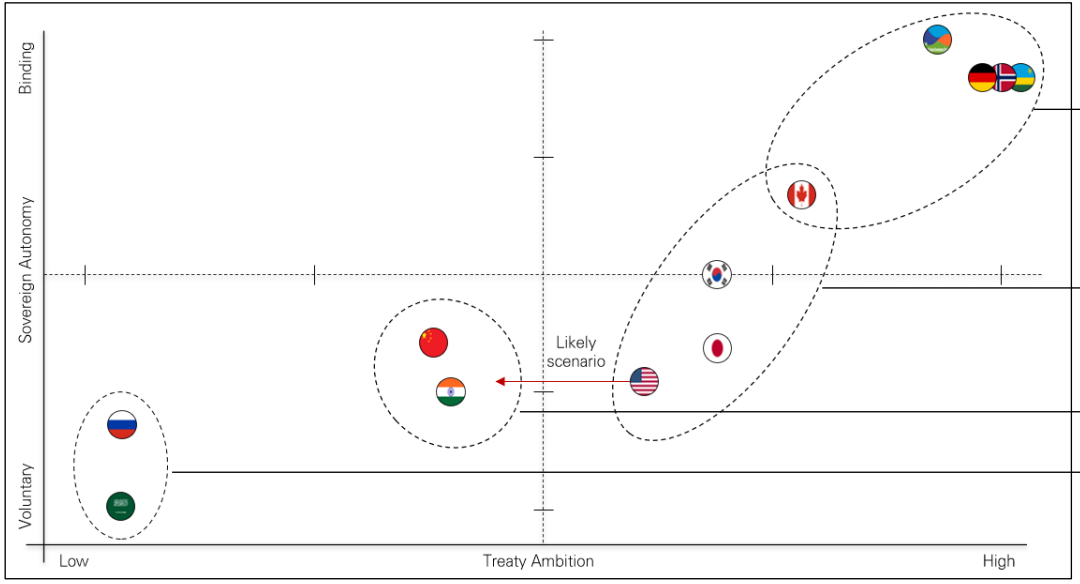
5.1. Findings: Main Stances Among Countries in INC-5



Treaty Maximalists Bloc

Support robust and far-reaching treaty provisions with strong legal obligations and enforcement mechanisms.

Pragmatic Ambition Bloc

Support strong action, but with emphasis on national implementation flexibility and interests

Reluctant Participants Bloc

Participates to avoid isolation, not out of strong normative alignment

Hardline Rejectionist Bloc

Oppose binding obligations due to high economic reliance on fossil fuels and petrochemicals

❖ Countries such as **South Korea, Japan**, and **Canada** acknowledge the urgency of addressing plastic pollution but face constraints in matching the high ambition levels of the **EU** and **SIDS** due to national economic interests and structural dependencies.

❖ Plastics are central to **Saudi Arabia's Vision 2030 strategy** (crude oil exports → value-added petrochemical products), and binding treaty provisions on production or chemicals would directly **threaten this core economic transition**.

❖ Similar to UNFCCC negotiations, **Saudia Arabia** and **Russia** share similar interests as Like-Minded Developing-Countries (LMDC). However, **SIDS** tend to adopt more ambitious positions in plastic treaty negotiations, as **ocean plastic pollution poses an especially severe threat** to their environments and economies.

5.2. Implications: How To Deal With Such Differing Stances

❖ Given the current policy direction of the **Trump administration**, the United States **is expected to retreat from the plastic treaty** process and may align more closely with the positions of China and India.

❖ Nations with **already advanced recycling systems and comprehensive waste management laws** advocate for the **international transferability of such regulations**. In contrast, countries with **less developed systems** emphasize the need for **national sovereignty and flexibility** within any global framework.

Two Track Strategy Approach

Treaty First, Binding Later

Given the collective influence of the **U.S., China**, and **India**, advancing a global plastics treaty without their support would be **politically unrealistic** from a realist perspective (see Krasner, 1983; Waltz, 1979).

As such, a more pragmatic approach would **prioritize initial agreement** on core elements—such as **plastic production and chemical additives**—while introducing **legally binding measures gradually** through a phased or modular treaty architecture

Treaty With Binding Force, Incentives To Join

Given the likely **difficulty of securing strong legal obligations at a later stage**, the treaty should initially be **anchored by a coalition of like-minded, high-ambition states** committed to legally binding provisions.

With mechanisms like the CBAM, **non-participant countries could later be incentivized (or pressured) to join through institutional levers**.

The success of this strategy would **rely on the positioning** of Pragmatic Ambition Bloc countries (**South Korea, Japan**, and **Canada**)

Limitations **As such text-based ML and AI sentiment analysis are a very experimental method, some methodological limitations are expected**

Limited Replicability – Due to the evolving and non-transparent nature of LLM outputs, results may vary across models, versions, or prompt phrasing. **Insufficient Cross-Country Coverage** – Current analysis may underrepresent countries with limited documentation, weak digital records, or non-English submissions. **Bootstraping Required for Robustness** – More iterations, data augmentation, or ensemble methods are needed to enhance reliability of findings.

Thank You

For any inquiries, please contact

Ministry of Foreign Affairs
Republic of Korea

Email
tkkim24@mofa.go.kr
donkeeKim@gmail.com

Phone No.
+82 2 2100 8475
+82 10 5407 1872