Supplementary Materials

Validating a Mixed-Method Approach for Multilingual News Framing Analysis: A case study of COVID-19

S1. Model Tuning

Parameters for model tuning

In our observations, the Louvain algorithm consistently delivered the most satisfactory community detection results for six out of seven corpora. We found that Louvain generally outperformed other algorithms when the weights of nodes and edges were more balanced across all clusters. However, when capturing smaller clusters, such as the *Scientific* frame, the fast greedy algorithm might show a stronger performance advantage. Most community detection algorithms produced five to six clusters under the default settings, aligning closely with the five predetermined frames we anticipated for the COVID-19 pandemic news issue.

By adopting the backbone filtering setting outlined in the previous ANTMN paper (Walter et al., 2022), we successfully filter out weak connections while retaining all topic nodes to detect frame clusters. The established backbone filtering algorithm, proposed by network scientists (Serrano et al., 2009), filters out weaker edges while preserving the essential information of the original network structure both globally and locally. A higher value of backbone α leads to the removal of more weak edges, resulting in a less connected network. Our network visualization reveals that all generated networks exhibit a similar level of interconnectedness, ensuring consistency in our topic networks and clustering outcomes.

Table S1

Model specifications and clustering results for each corpus

Corpus	Algorithms	No. of Communities	Backbone α	LDA k	LDA α
Hong Kong	Louvain	5	0.10	50	0.05
Taiwan	Fastgreed	6	0.35	50	0.05
Korea	Louvain	4	0.10	50	0.05
Turkey	Louvain	6	0.10	50	0.05
Germany	Louvain	5	0.15	50	0.05
Uganda	Louvain	5	0.35	50	0.05
United States	Louvain	5	0.15	50	0.05

Identifying optimal number of topics (k)

We rely on the perplexity score to determine the optimal number of topics for the topic model (k) and the document-topic density (α). Figure S1 below shows the perplexity scores of different candidate models with different k and α. We then calculate the second derivative of all perplexity score changes to find the maximum point. The maximum point means that increasing the number of k will give diminishing returns. Figure S2 shows that the optimal number of k is 50 given α equals 0.05.

Figure S1

Perplexity scores of candidate models

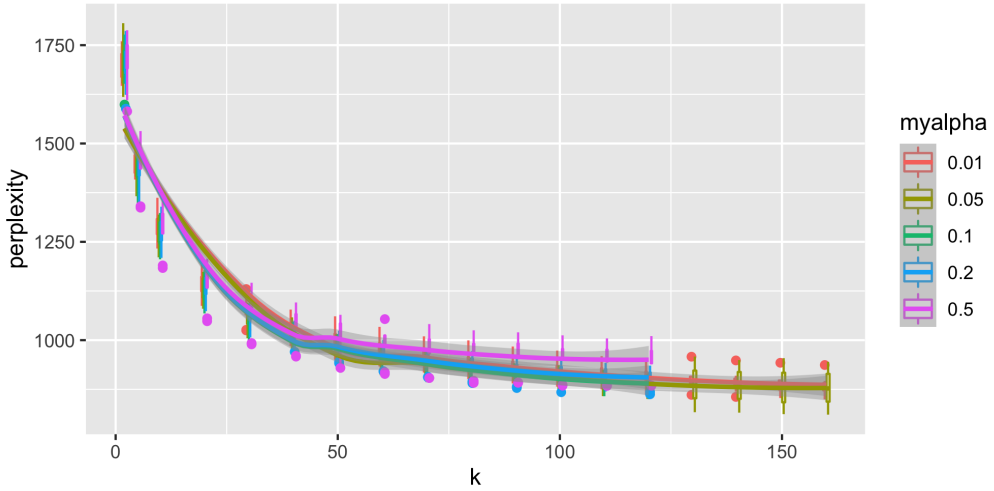
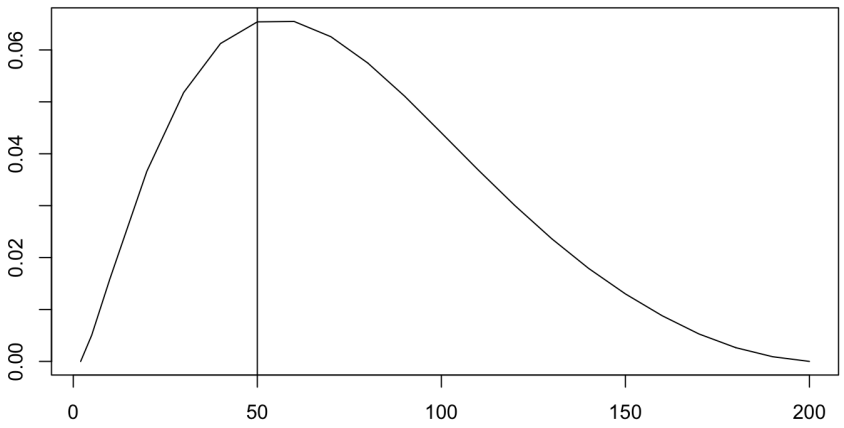


Figure S2

Calculating the maximum point for the second derivative of perplexity scores changes (alpha=0.05) for the Taiwan corpus. Vertical line at k=50.



S2. Classification Report

Table S2

Hong Kong

Frame	precision	recall	f1-score	support
Containment	0.93	0.93	0.93	15
Scientific	0.59	1.00	0.74	13
Politics	0.85	0.61	0.71	18
Economic	0.88	0.96	0.92	23
Social	0.96	0.77	0.86	31
Overall Performance				
Accuracy			0.84	100
Macro avg	0.84	0.86	0.83	100
Weighted avg	0.87	0.84	0.84	100

Taiwan

Frame	precision	recall	f1-score	support
Containment	0.85	0.98	0.91	45
Scientific	1.00	0.71	0.83	7
Politics	0.87	0.91	0.89	22
Economic	1.00	0.77	0.87	13
Social	1.00	0.67	0.80	9
Overall Performance				
Accuracy			0.89	96
Macro avg	0.94	0.81	0.86	96
Weighted avg	0.90	0.89	0.88	96

Korea

Frame	precision	recall	f1-score	support
Containment	0.94	0.92	0.93	36
Scientific	-	-	-	1
Politics	0.59	1.00	0.75	19
Economic	0.75	0.43	0.55	7
Social	0.93	0.75	0.83	36
Overall Performance				
Accuracy			0.82	100
Macro avg*	0.80 (0.54)	0.78 (0.52)	0.76 (0.51)	100
Weighted avg	0.84	0.82	0.81	100

*Macro-averaging precision, recall, and F1 scores were calculated for the Korea corpus in two scenarios: with four classes (excluding *Scientific*) and with five classes (including *Scientific*). The results for the five classes are presented in parentheses.

Turkey

Frame	precision	recall	f1-score	support
Containment	0.90	0.69	0.78	26
Scientific	0.46	1.00	0.63	11
Politics	0.83	0.77	0.80	13
Economic	1.00	0.88	0.94	17
Social	0.95	0.78	0.86	23
Overall Performance				
Accuracy			0.80	90
Macro avg	0.83	0.83	0.80	90
Weighted avg	0.87	0.80	0.81	90

Germany

Frame	precision	recall	f1-score	support
Containment	0.84	0.84	0.84	37
Scientific	1.00	0.75	0.86	4
Politics	0.75	0.80	0.77	15
Economic	0.83	0.77	0.80	13
Social	0.81	0.83	0.82	30
Overall Performance				
Accuracy			0.82	99
Macro avg	0.85	0.80	0.82	99
Weighted avg	0.82	0.82	0.82	99

Uganda

Frame	precision	recall	f1-score	support
Containment	0.93	0.76	0.83	33
Scientific	0.62	1.00	0.77	5
Politics	0.68	0.95	0.79	22
Economic	1.00	0.68	0.81	22
Social	0.74	0.78	0.76	18
Overall Performance				
Accuracy			0.80	100
Macro avg	0.79	0.83	0.79	100
Weighted avg	0.84	0.80	0.80	100

United States

Frame	precision	recall	f1-score	support
Containment	0.64	1.00	0.78	14
Scientific	1.00	0.86	0.92	7
Politics	0.96	0.82	0.88	28
Economic	1.00	0.94	0.97	18
Social	0.97	0.91	0.94	33
Overall Performance				
Accuracy			0.90	100
Macro avg	0.91	0.91	0.90	100
Weighted avg	0.93	0.90	0.91	100

S3. Examining the Impact of Word Frequency Cutoff in Pruning

While we acknowledge that the implication of the frequency cutoff for pruning will vary with the corpus size, we have opted for a singular value (0.5% for the lower level cutoff) in the manuscript in order to standardize the model tuning across multiple corpora and languages. In this appendix, we provide further justification for selecting a frequency cutoff of 0.5% to maintain relatively equal amounts of information (i.e., unique tokens) across each LDA model, while also examining the potential impact of adjusting the frequency cutoff based on corpus size on our LDA and clustering results in our largest corpus (e.g., US corpus).

Table S3

Token Frequency

Corpus	No. of Unique Token Used	Upper Bound for Word Frequency
Germany	5455	63.65%
Hong Kong	4206	71.05%
Korea	5883	92.47%
Taiwan	4638	91.68%
Turkey	5703	43.70%
Uganda	5735	86.80%
United States	7190	76.55%

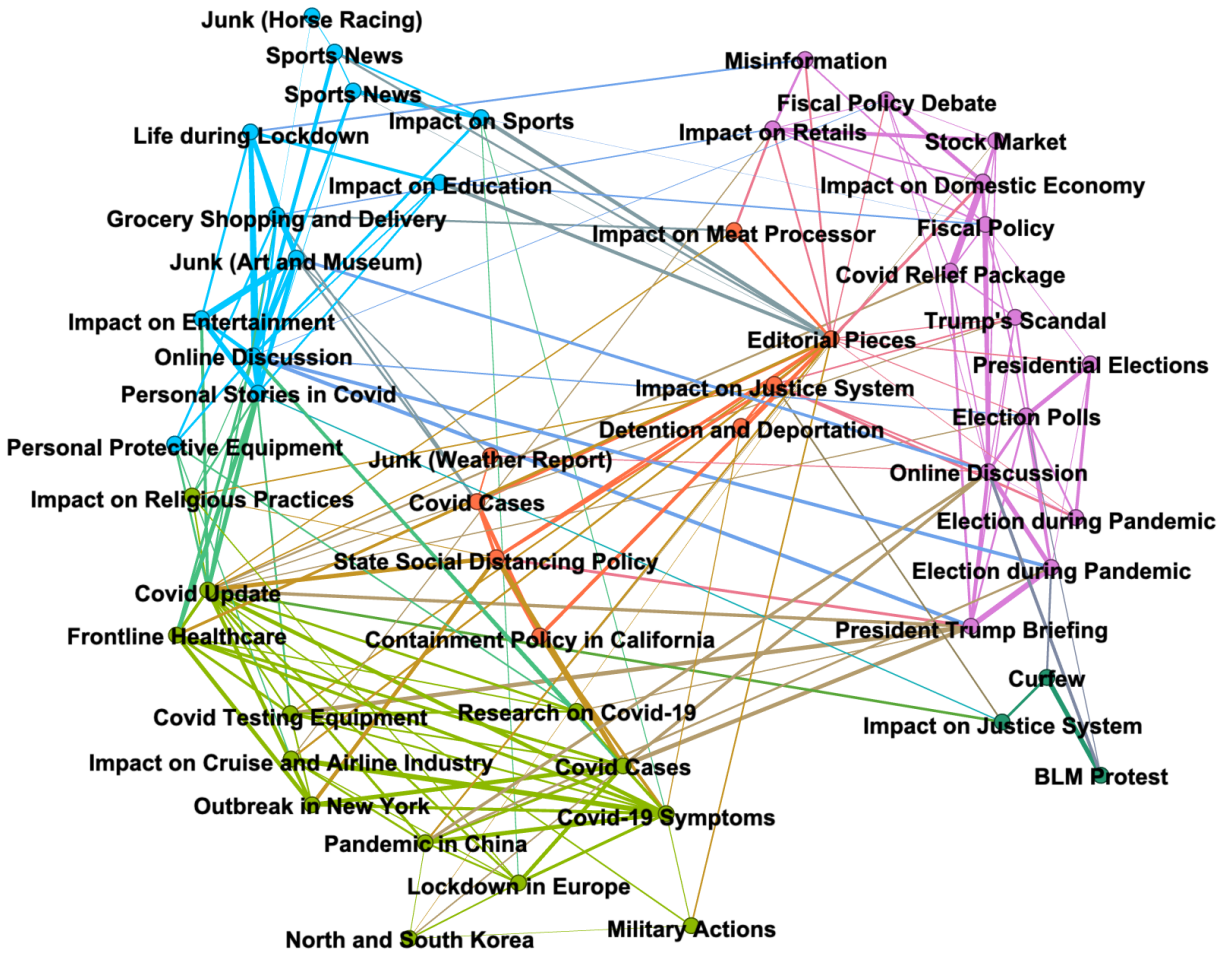
According to Table S3 , the upper bound for word frequency distribution varies substantially across languages and corpora. For instance, due to Turkish being an agglutinative language in which words are formed by binding multiple affixes to the root, the maximum word frequency is relatively smaller than any other corpora.

Considering the variations in corpus size, larger corpora are more likely to filter out a greater number of unique and infrequent tokens compared to smaller corpora. To address this concern, we conducted an additional ANTMN modeling on the US corpus, normalizing the lower-level cutoff based on the smallest corpus (e.g., Uganda with $n \approx 10{,}000$). We ran the LDA and community detection processes with the new pruning cutoff of 0.03% for the US corpus. We observed that the lower cutoff generated very similar results at the topic level based on both keywords and top texts, though it produced more junk topic clusters such as weather reports, horse racing, and art museums, compared to the default cutoff level. In terms of network clusters, the lower cutoff largely resembled the five pre-determined frames, though the clustering was not as coherent as the higher cutoff, and it was challenging for *economic consequence* and *politics*

clusters to split off due to the presence of junk clusters and more weak edges. Overall, no substantial variation was observed. We recommend that future studies conduct systematic sensitivity analyses to investigate the impact of this cutoff on the performance of LDA and ANTMN.

Figure S3

US COVID-19 Corpus with a Lower Cutoff for the Word Frequency



S4. Cluster Distinctiveness Illustrated by Frame Keywords

Table S4

Hong Kong

Frame	Keywords
Containment	診 確 個案 宗 歲 中心 生 衞 患者 第 肺炎 新增 曾 一名 名 防護 人 今日 本港 新冠 diagnosis, confirmed, case, total, age, center, health, patient, rank, pneumonia, new, added, previously, one, name, protection, person, today, Hong Kong, covid-19
Scientific	病毒 冠狀 武漢 新型 研究 感染 肺炎 傳播 新冠 發現 人 專家 疾病 中心 流感 大學 患者 基因 傳染病 出現 virus, coronavirus, Wuhan, novel, research, infection, pneumonia, transmission, covid-19, discovery, people, experts, disease, center, influenza, university, patients, genetics, infectious disease, emergence
Politics	美國 特 普 朗 總統 疫 情 州 白宮 斯 登 選 拜 新冠 人 將 大 民主黨 trump 政府 United States, president, epidemic, state, White House, Biden, coronavirus, people, election, covid-19, great, democratic party, Trump, government
Economic	經濟 情 疫 中國 影響 企業 全球 增長 市場 將 肺炎 新冠 消費 今年 內地 數據 生產 政策 復工 衝擊 economy, situation, epidemic, china, impact, enterprise, global, growth, market, will, pneumonia, novel coronavirus, consumption, this year, mainland, data, production, policy, resumption of work, impact
Social	賽 球員 球 斯 場 肺炎 超 球隊 英 事 拿 新冠 隊 聯賽 足 getty images 季 比賽 athlete, ball player, ball, stadium, pneumonia, super, team, english, matter, catch, covid-19, team, league, football, getty images, season, match

Taiwan

Frame	Top Keywords
Containment	病例, 死亡, 累計, **口罩**, **戴**, **民眾**, **距離**, **防疫**, 檢疫, 居家, 隔離 cases, dealth, cumulative, masks, weak, public, distance, epidemic prevention, quarantine, home, isolation
Scientific	**疫苗**, **研發**, **藥物**, **試驗**, **臨床**, **治療**, **研究**, **檢測**, **檢驗**, **抗體**, **篩檢**, **結果** Vaccine, R&D, drug, trial, clinical, treatment, research, test, test, antibody, screening, result
Politics	美國, 川普, 總統, 疾病, 白宮, 官員, 疫情, 蓬佩奧, **台灣**, **台**, **合作**, **外交部** United States, Trump, President, Disease, White House, Officials, Epidemic, Pompeo, Taiwan, Taiwan, Cooperation, Ministry of Foreign Affairs
Economic	**公司**, **企業**, **員工**, **產業**, **科技**, **點**, **指數**, **元**, **股市**, **經濟**, **疫情**, **影響**, **衝擊**, **成長** Company, Enterprise, Employee, Industry, point, index, yuan, stock market, economy, epidemic, impact, shock, growth

Social	人, 讓, 被, 沒有, 歲, 要, 一個, 奧運, 比賽, 聯盟, 球員, 活動, 舉行, 舉辦, 疫情, 會議 person, let, being, no, year-old, want, one, Olympic, game, league, player, Event, Hold, Hold, Epidemic, Conference

Korea

Frame	Keywords
Containment	확진, 자가격리, 증상, 중국, 우한, 입국, 외국인, 검사, 격리, 감염, 서울, 이태원, 클럽, 치료, 입원, 경찰, 위반, 확진자, 백신, 항바이러스제, 신천지, 대구, 일본, 아베,도쿄,의료,마스크,집 confirmation, self-isolation, symptom, China, Wuhan, entry, foreigner, test, quarantine, infection, Seoul, Itaewon, club, treatment, hospitalization, police, violation, confirmed cases, vaccine, antiviral drug, Shincheonji, Daegu, Japan, Abe, Tokyo, medical, mask, home
Politics	민주당, 총선, 한국, 영국, 이탈리아, 프랑스, 미국, 트럼프, 문재인, 대통령, 청와대, 지지, 정부, 중국, WHO, 홍콩, 지급, 긴급재난지원금, 고용, 공무원, 북한, 설문조사, 투표, 바이러스 Democratic Party, general election, Korea, UK, Italy, France, USA, Trump, Moon Jae-in, President, Blue House, support, government, China, WHO, Hong Kong, payment, emergency disaster subsidy, employment, officials, North Korea, survey, vote, virus
Economic	분기별, 감소, 달러, 미국, 투자, 경제, 세계, 글로벌, 금융, 공장, 자동차, 국내, LG, SK, 생산, 아파트, 부동산 Quarterly, decrease, dollar, US, investment, economy, world, global, finance, factory, automobile, domestic, LG, SK, production, apartment, real estate
Social	지역, 어려움, 리그, 거리, 새로운, 기업, 비즈니스, 온라인, 영화, 유튜브, TV, 판매, 상품, 학교, 학생, 일정, 연기, IT, 비대면, 올림픽 Region, difficulty, league, distance, new, corporate, business, online, movie, YouTube, TV, sales, product, school, student, schedule, postponement, IT, non-face-to-face, Olympics

Turkey

Frame	Top Keywords
Containment	vaka, sayısı, son, kişi, sayısının, hayatını, ülkede, ölü, başbakan, hafta, yeni, sağlık, çin, yeni, tespit, maske, sosyal, mesafe case, count, last, person, count, life, country, dead, prime minister, week, new, health, china, new, detected, mask, social, distance
Scientific	tedavi, hastalığı, solunum, hasta, yoğun, yeni, bilim, virüs, aşı, ilaç, prof, virüs, sosyal, dünya, sağlık, dsö, ghebreyesus cure, disease, respiratory, sick, intense, new, science, virus, vaccine, drug, Prof, virus, social, world, health, WHO, Ghebreyesus
Politics	chp, genel, devlet, türkiye, parti, milletvekili, siyasi, akp, erdoğan, başkanı, belediye, genel, büyükşehir, istanbul, ceza, infaz CHP, general, state, turkey, party, deputy, political, AKP, Erdogan, mayor, municipality, general, metropolitan, istanbul, punishment, execution
Economic	büyük, dolar, yüzde, yıl, yaklaşık, fazla, şirket, şirketin, küresel, ekonomik, merkez, yüzde, küresel, faiz, para, bankası big, dollars, percent, year, about, surplus, company, company, global, economic, center, percent, global, interest, money, bank

Social	zaman, konuştu, dedi, şekilde, devam, büyük, anda, önemli, evde, futbol, spor, lig, tff, çocuk, kadın, sosyal, aile time, spoke, said, way, continue, great, at the moment, important, at home, soccer, sports, league, TFF, children, women, social, family

Germany

Frame	Top Keywords
Containment	sagte, dpa, anzeige, berlin, tragen, maskenpflicht, kunden, viele, sei, mitarbeiter, zahl, menschen, fälle, dpa said, dpa, advertisement, berlin, wear, mask requirement, customers, many, be, employee, number, people, cases, dpa
Scientific	dass, virus, menschen, studie, forscher, covid-19, impfstoff, russland, bereits, unternehmen, impfstoffe, erste, deutschland that, virus, people, study, researcher, researcher, covid-19, vaccine, russia, already, company, vaccines, first, germany
Politics	dass, sei, worden, wurde, kritik, partei, spd, grünen, wahl, regierung, trump, usa, donald, new, us-präsident that, was, been, became, criticism, party, spd, green, election, government, trump, usa, donald, new, us president
Economic	unternehmen, mehr, coronakrise, euro, millionen, prozent, lufthansa, produktion, unternehmen company, more, corona crisis, euro, million, percent, lufthansa, production, company
Social	dass, ja, schon, gibt, immer, wurde, frau, dass, jahre, wegen, abgesagt, stattfinden, märz that, yes, already, there, always, became, woman, that, years, because of, cancelled, take place

Uganda

Frame	Top Keywords
Containment	cases, confirmed, tested, new, covid-19, district, gulu, resident, health, tested, positive, quarantine
Scientific	vaccine, hiv, drug, treatment, covid-19, patients, drugs, malaria, virus, used, diseases
Politics	president, museveni, said, country, lockdown, elections, election, uganda, yoweri, address, electoral, party
Economic	development, uganda, sector, new, bank, financial, products, production, local, mtn, customers, money
Social	can, people, time, us, many, must, church, uganda, god, day, children, women, violence, refugees

United States

Frame	Top Keywords
Containment	cases, climate, park, space, weekday, daily, cases, deaths, new, covid-19, people, countries, virus, government
Scientific	vaccine, drug, covid-19, patients, symptoms, research, treatment, hydroxychloroquine, clinical, fda, health
Politics	trump, president, "trumps", donald, news, percent, poll, voters, biden, campaign, democratic, election, voting, police, protests, black
Economic	house, senate, bill, democrats, congress, million, money, billion, workers, employees, work, percent, washington, one
Social	going, people, think, just, now, children, said, players, season, league, school, students, church, instagram, shared

S5. Details on Data Collection

We utilized a combination of news archives, news aggregators, and scraping toolkits such as Nexis Uni, LexisNexis, NAVER, NewsPaper3k, Webscraper, etc., to gather domestic news from each region. We have provided detailed documentation for each corpus and data collection approach:

Hong Kong, Taiwan, United States, Germany: The URLs and metadata of news articles for each corpus were first collected through a combination of Nexis Uni and LexisNexis news archives. Then, Newspaper3k, a Python-based news scraping package, was used to collect the full text for each article.

Uganda: To overcome the absence of standardization in Ugandan news websites, a manual web scraping approach was adopted instead of directly utilizing Newspaper3k. This involved utilizing the Beautiful Soup package in Python, supplemented by the Chrome Driver where necessary, to accommodate the specific website infrastructures and restrictions.

Turkey: Due to the lack of domestic-audience targeting Turkish newspapers in the LexisNexis news archive, we gathered the articles directly from individual newspapers' websites. The selection of the two outlets was driven by the need to maintain a balance between pro-government and opposition news sources, as well as the measures implemented against scraping on other newspaper websites. The article URLs were scraped using a browser extension (webscraper.io) that provides features like pagination handling and click interactions to deal with structural challenges in the websites. Later, Newspaper3k was used to collect the full text for each article.

Korea: Among the *BBC's top news outlets* of South Korea, domestic daily newspapers that cover a broad range of affairs and fields, rather than specializing in a particular area, were selected. As the news stories from these selected newspapers are all published through Naver, the largest news aggregating service in Korea, all news articles containing the specified search query were scraped from this website using the R package *rvest*.

S6. Directly Utilizing LDA with a Small *k* for Frame Detection

To examine whether LDA with an equally small number of topic clusters (k = 5) can capture frame-level information in a corpus, we ran LDA with $k = 5$ and $\alpha = 0.05$ on the Taiwan, Uganda, and Korea corpora (see Table S5). In this approach, each LDA cluster is directly operationalized as a frame cluster. In the Uganda corpus, out of the five frame clusters, LDA produces three *Containment* frame clusters, capturing different aspects of containment such as the *International outbreak*, *Covid-19 cases*, and *Government and president response* (which falls between *Containment* and *Politics*), while missing relatively smaller frames like *Scientific*. Similarly, in the Taiwan corpus, LDA produces three *Containment* frame clusters, covering *International outbreak*, *Asian outbreak*, and *Domestic outbreak*, while smaller frames like *Scientific* and *Social* are missing. The Korea corpus exhibits a relatively consistent result with its outcome from ANTMN. Its LDA frame detection generates two frame clusters related to the *Containment* frame such as *International Outbreak* and *Covid-19 cases*, along with *Politics* and *Economic consequences*. However, it still fails to detect the *Scientific* frame cluster.

Consistent with our theoretical discussion and previous studies (Guo et al., 2022), LDA overemphasizes low-level semantic information (e.g., keywords) and has a high tendency to disproportionately generate the *Containment* frame due to significant overlap between *Containment* keywords and the theme of the COVID-19 dataset. In other words, keywords from the *Containment* frame are largely similar to common words in the COVID-19 pandemic news. On the other hand, ANTMN, by capturing more granular topics in the first step and then utilizing a community detection algorithm to group these topics rather than relying on low-level semantic signals (i.e., keywords), can handle smaller frame clusters (e.g., *Scientific*) better than directly utilizing LDA with a small *k* for frame detection

Table S5

Frames Detected in the Uganda Corpus

Frames	Keywords
International outbreak (Containment)	said, covid-19, countries, world, virus, health, africa, pandemic, people, new, china, us, united, first, also, african, cases, afp, president, states
Government and president response (Containment/Politics)	said, district, covid-19, people, president, police, government, mr, uganda, food, kampala, also, museveni, parliament, public, security, says, minister, money, court
Covid-19 cases (Containment)	health, covid-19, cases, uganda, said, ministry, drivers, hospital, dr, truck, tested, confirmed, positive, country, patients, people, border, new, number, virus
Social and religious Life (Social)	people, can, covid-19, one, time, also, many, home, children, like, health, says, uganda, lockdown, us, even, social, need, work, now
Economic consequences	uganda, covid-19, government, said, pandemic, also, support, per, sector, business, bank, economy, economic, financial, million, development, billion, businesses, cent, year

Frames Detected in the Taiwan Corpus

Frames	Keywords
International outbreak (Containment)	中國, 台灣, 在, 疫, 與, 情, 病毒, 對, 是, 美國, 武漢, 表示, 日, 和, 也, 國家, 肺炎, 中 China, Taiwan, in, epidemic, and, love, virus, right, yes, United States, Wuhan, Express, day, and, also, country, pneumonia, center
Asian outbreak (Containment)	診, 確, 日, 例, 病例, 人, 的, 武漢, 肺炎, 疫, 感染, 萬, 新增, 情, 病毒, 死亡, 累計, 起, 日本, 月 diagnosis, confirm, day, case, case, person, of, Wuhan, pneumonia, epidemic, infection, ten thousand, new, love, virus, death, cumulative, from, Japan, month
Domestic outbreak (Containment)	日, 疫, 情, 在, 時, 防疫, 中心, 口罩, 有, 指揮, 表示, 武漢, 中, 陳, 肺炎, 台灣, 人, 月 day, epidemic, condition, in, time, epidemic prevention, center, mask, has, command, expression, Wuhan, center, Chen, Pneumonia, Taiwan, people, month
International Politics (Politics)	在, 日, 美國, 和, 表示, 疫, 年, 情, 病毒, 月, 武漢, 肺炎, 與, 冠狀, 將, covid-19, 普, 疾病, 人 in, day, United States, and, expression, epidemic, year, feeling, virus, month, Wuhan, pneumonia, with, corona, will, covid-19, general, disease, person
Economic consequences	疫, 情, 經濟, 月, 日, 在, 年, 也, 肺炎, 將, 武漢, 困, 紓, 及, 影響, 股, 為, 衝擊, 元 epidemic, feeling, economy, month, day, in, year, also, pneumonia, will, Wuhan, relief, relief, and, impact, share, for, impact, yuan

Frames Detected in the Korea Corpus

Frames	Keywords
International outbreak (Containment)	중국, 우한, 미국, 신종, 트럼프, 바이러스, 일본, 미, 대한, 감염증, 현지, 한국, 폐렴, 정부, 입국, 감염, WHO, 세계, 확진자, 영구, 확산, 조치, 홍콩, 방역, 이탈리아, 백신, 아베 China, Wuhan, USA, new, Trump, virus, Japan, USA, Korea, infection, local, Korea, pneumonia, government, entry, infection, WHO, world, confirmed case, permanent, spread, measures, Hong Kong, quarantine, Italy , vaccine, Abe
Politics	대한, 문, 대통령, 문재인, 총선, 민주당, 서울, 청와대, 국회, 정부, 대표, 선거, 경제, 열린, 국민, 한국, 새로운, 우리는, 좋은, 같다, 더불어민주당, 미래통합당 Korea, Moon, President, Moon Jae-in, general election, Democratic Party, Seoul, Blue House, National Assembly, government, representative, election, economy, open, people, Republic of Korea, new, we are, good, same, Democratic Party of Korea, Future Integration Party
Covid-19 cases (Containment)	확진, 확진자, 검사, 신천지, 환자, 분류, 대구, 감염증, 서울, 번째, 신종, 격리, 경기, 우한, 증상, 추가, 관련, 검사, 환자, 양성, 결과, 병원, 자가격리 Confirmation, confirmed case, test, Shincheonji, patient, classification, Daegu, infectious disease, Seoul, th, new type, quarantine, Gyeonggi, Wuhan, symptom, addition, related, test, patient, positive, result, hospital, self-isolation
Social	마스크, 온라인, 서울, 신종, 감염증, 지역, 전국, 관계자, 집, 대한, 방역, 대구, 확산, 학교, 다양한, 어려움, 거리, 직접, 디지털, 지원, 감염, 시간, 등교, 감염병 Mask, online, Seoul, new infection, region, nationwide, officials, home, Korea, quarantine, Daegu, spread, school, various, difficulties, distance, direct, digital, support, infection, time, school attendance, infectious disease
Economic consequences	억원, 국내, 대비, 경제, 약, 미국, 글로벌, 세계, 분기, 최대, 차, 기업, 지원, 대한, 사태, 크게, 달러, 포인트, 정부, 경제, 관계자, 주요, 정부, 시장, 투자, 자동차, 위기, 수출, 규모 KRW 100 million, domestic, contrast, economy, about, US, global, world, quarter, maximum, difference, company, support, for, situation, big, dollar, point, government, economy, officials, major, government, market, investment, car, crisis, export, scale

S7. Articles with Multiple Dominant Frames

Table S6

Exemplary Articles with Multiple Dominant Frames

Corpus	Headline	Summary / Discussion	Containment	Scientific	Politics	Economic	Social	Dominant Frames
Hong Kong	醫院文員分享dirty team病房實況籲留家抗疫:護士清潔工無停手 Hospital Clerk Shares "Dirty Team" Ward Situation and Urges Home Quarantine: Nurses and Cleaners Never Stop Working	A person claiming to be a dirty team ward clerk posted on a Facebook page, sharing the busy situation in the wards. They urged the public to cooperate and stay at home.	53.49	1.26	0.37	1.40	35.72	Containment Social
	誰將最終執掌世界貿易組織　中美另一場新較量開始 Who Will Ultimately Lead the World Trade Organization: Another New Contest Begins Between China and the United States	Donald Trump has consistently opposed WHO continuing to classify China as a developing economy eligible for special treatment.	3.41	2.29	66.73	18.05	1.37	Politics Economic
Taiwan	好處高於風險 WHO:染疫媽媽仍可哺乳 The benefits outweigh the risks - WHO: Infected mothers can still breastfeed.	The article touches upon the containment aspect of breastfeeding, relies on expert opinions from the WHO, and addresses the family and societal implications of the recommendation.	46.90	14.02	1.19	5.66	32.05	Containment Scientific Social
	澳洲態度強硬 染疫郵輪一律請回 Australia adopts a tough stance, requiring all infected cruise ships to return	The article sheds light on Australia's efforts to control the spread of infections, presenting the situation of infected cruise ships as one that can be viewed as a social issue.	17.46	0.08	4.34	28.79	49.34	Containment Social

Korea	“대구경북 코로나 확산 너무 가슴 아파”… 정치적 효과 극대화할 타이밍 맞춘듯 “Daegu-Gyeongbuk Corona spread is so heartbreaking”… utilized to maximize the political effect.	Former president Park Geun-hey’e message expressed her concern over the surge in Covid-19 cases in her political hometown. The article suggests that her timing was politically strategic.	0.05	-	66.36	0.00	24.49	Politics Social
	황교안·심재철·곽상도·전희경 코로나19 음성 판정 Hwang Kyo-ahn, Shim Jae-cheol, Kwak Sang-do, and Jeon Hee-kyung have tested negative for COVID-19.	The four politicians, namely Hwang Kyo-ahn, Shim Jae-cheol, Kwak Sang-do, and Jeon Hee-kyung, have all received negative results for COVID-19 testing.	50.48	-	31.14	0.00	0.15	Containment Politics
Turkey	Almanya'da 13 kulüp iflasın eşiğinde 13 clubs in Germany on the verge of bankruptcy	The article discusses the suspension of soccer leagues in Germany with a specific focus on economical impacts on clubs	0.08	0.11	0.12	36.67	62.97	Social Economic
	Hazine ve Maliye Bakanı Albayrak: Pozitif bir büyüme ile bu yılı kapatacağız Treasury and Finance Minister Albayrak: We will close this year with positive growth	The article mentions a recent statement given by the minister as a response to opposition’s criticism of economy policies	0.00	0.51	40.61	33.51	25.33	Politics Economic
Germany	Göttingen: Hunderte Corona-Tests in Wohnanlage geplant Hundreds of COVID-19 tests planned in residential complex	The planned testing to control the spread of COVID-19 within the complex and the potential impact on the residents and the wider community.	77.84	4.51	1.37	1.96	14.12	Containment Social
	Die Coronavirus-Pandemie hält die gesamte Welt weiterhin in Atem The coronavirus pandemic continues to keep the entire world on edge	The article tracks the spreading pattern of COVID-19, acknowledges the need to keep the world on edge to control the spread of the virus, and discusses the impact on individuals’ lives.	33.35	35.49	1.26	6.05	23.81	Scientific Containment Social

Uganda	Museveni Hails Denmark on Agriculture Support, COVID19 Fight	President Museveni's briefing on the commendable efforts in agriculture support and the ongoing fight against COVID-19	42.86	3.52	38.69	14.69	0.23	Politics Containment
	Covid-19: Zanzibar Airport Staff Undergo Prevention, Detection Training, Move to Welcome Travelers	The social aspect of impacting individuals' ability to travel and the containment measure to control the spread of diseases and safeguard public health.	31.27	0.14	23.04	13.79	29.02	Social Containment
United States	No, Trump can't magically lift the coronavirus restrictions in 15 days	The concern that President Trump could have contracted and spread COVID-19 within a 15-day period raises questions about containment and the potential impact on individuals' social lives.	24.13	11.47	20.37	21.38	22.59	Politics Containment Social
	Remember when we had hope? First Lady Michelle Obama is here to remind you!	Former First Lady Michelle Obama can be regarded as a significant figure encompassing both political and social spheres.	1.04	0.09	29.31	8.38	61.12	Social Politics

S8. Exploring the Link between the Scientific and Containment Frames in the Korean Case

The ANTMN analysis of the Korea corpus failed to capture the *Scientific* frame, despite the presence of two scientific topics: *Aerosol Transmission and Symptomlessness* and *Vaccine Development*. Instead, these scientific topics were incorporated into the *Containment* frame. Particularly, the topic of *Aerosol Transmission and Symptomlessness* demonstrated a strong association with the "*Outbreak in Wuhan, China*" topic within the *Containment* frame. This connection played a significant role in blurring the boundary between the *Scientific* and *Containment* frames. On the other hand, *Vaccine Development* did not exhibit any connections to the topics within the *Containment* frame.

Both *Aerosol Transmission and Symptomlessness* and *Outbreak in Wuhan, China* indeed employed similar language, referring to COVID-19 as "Wuhan pneumonia" and providing simultaneous coverage of its outbreaks, symptoms, and transmission. For instance, one news story assigned to the *Aerosol Transmission and Symptomless* topic[1] (titled "Following China, WHO said 'symptomless people can spread the virus'") published by *Chosun Ilbo* on January 30th, 2020, states the following:

> *"Further investigation is required regarding **the Wuhan pneumonia**, but there is a possibility that asymptomatic infected individuals can also transmit the virus."*
>
> *"Among those who had close contact with the **four confirmed patients** in Korea, no additional cases have been confirmed yet."*

Similarly, a news story associated with the *Outbreaks in Wuhan, China* topic[2] (titled "Human-to-human transmission of Wuhan Pneumonia") published by *Chosun Ilbo* on January 1st, 2021, reads as follows:

> *"With over **200 patients having been confirmed** with **pneumonia** caused by the new coronavirus in China, concerns about its spread are increasing."*
>
> *"Chinese health authorities have verified that **Wuhan pneumonia** is **contagious from person to person**. (...) **A respiratory expert** mentioned that two cases of new coronavirus infections in southern Guangdong were confirmed to be instances of **human-to-human transmission.** (...) The expert added that patients can contract the new coronavirus without personally visiting the city."*

As observed in these examples, the usage of "Wuhan" and the inclusion of information not only about the cases but also about the symptoms and transmission methods appear to play a significant role in establishing connections between these specific topic nodes.

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[1] https://n.news.naver.com/mnews/article/023/0003503974?sid=102

[2] https://n.news.naver.com/mnews/article/023/0003502116?sid=104

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