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Chronicling transitions in Baltic media: a longitudinal topic analysis of *The Baltic Times*' coverage from the post-Soviet era to European integration (1998–2024)

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ABSTRACT

A computational analysis of *The Baltic Times*' coverage from 1998 to 2024 documents the Baltic states' transition using natural language processing techniques. Examining 40,471 articles through topic modeling, Named Entity Recognition, and sentiment analysis, this study identifies changing themes in politics and other developments. Focusing on geopolitical and regional security issues, this article explores how this transnational publication presents the region's transformations alongside defense spending changes. It also addresses a gap in Baltic media research and demonstrates the potential of large-scale text analysis for expanding our understanding of how transnational media present regional developments for international audiences and elite stakeholders.

KEYWORDS *The Baltic Times*; Baltic states; thematic analysis; topic modeling; media coverage; geopolitics and security; European integration; longitudinal analysis

The Baltic region is a place where strategic geopolitics, cultural integration, and historical change all come together. According to Clemens (2016), Kuldkepp, Piirimäe, and Aunesluoma (2022), Piirimäe and Mertelsmann (2018), and Solska (2013), Estonia, Latvia, and Lithuania have all spent centuries under the influence of their neighbors, and their shared historical experiences under Soviet rule have contributed to their unique yet interconnected identities. From Soviet republics to active members of the EU and the NATO, these nations have seen significant changes since regaining their independence in the early 1990s. In addition to changing their political, economic, and social environments, membership in these organizations has strengthened their positions as active participants in regional crisis management within the larger framework of European security (Clarke 2023; Grigas 2016; Kasekamp 2017; Mälksoo 2009).

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The security situation in the Baltic region has been particularly noteworthy, as Estonia, Latvia, and Lithuania still feel more threatened and vulnerable than other EU states (Jakniunaite 2016). The vulnerable position of these younger EU democracies has drastically changed since 2014, when they became Europe's frontline states and faced a growing number of military and nonmilitary challenges (Major and von Voss 2016). They are now essential components of Western security structures (Lawrence and Jermalavicius 2013). Recent developments have heightened concern about regional security even further, sparking what German Chancellor Olaf Scholz termed the 'Zeitenwende': a significant inflection point in global geopolitics (Crowther 2023).

Each Baltic state has followed a unique road toward democratization and governance that has been characterized by rapid institutional reforms and technological advancements. Estonia, for instance, has been at the forefront of the development of e-governance, improving cybersecurity, citizen involvement, and state functionality. This paradigm is currently seen as a model inside the EU (Anthes 2015; Espinosa and Pino 2024; Himma-Kadakas and Kõuts-Klemm 2023; Kalvet 2012; Kitsing 2011). The Baltic states have created digital initiatives as part of their governing strategies, including measures to fight against digital misinformation and hybrid crises (Balčytienė, Bocullo, and Juraite 2024; Hardy 2024; King and McNabb 2014; Rivza and Rivza 2020). In order to combat complex crises, these nations have also established strong cybersecurity frameworks and made digital defense capabilities essential to regional security (Dumchikov, Utkina, and Bondarenko 2022; Górka 2023; Mix 2020; Stevenson 2022; Veebel 2017).

The Baltic Times, which was established in 1996 through the merger of *The Baltic Independent* and *The Baltic Observer*, serves as the longest-running transnational English-language publication that chronicles developments in the Baltic region (Eurozine 2025). As a monthly publication, it provides long-form, thorough, and up-to-date information, and its news reports and commentaries give readers vital knowledge for understanding the three Baltic countries and their neighbors. Providing crucial insights into the Baltic states' changing identities in the post-Soviet and European contexts, it caters to both regional and international elites, businesspeople, politicians, and other transnational stakeholders. These aspects make it particularly valuable for assessing how regional Baltic developments are presented to international readers over time. The newspaper covers political, economic, and cultural transitions, documenting developments in democratization and Western integration that are of key interest to researchers (Arens 2021; Charles 2009; Sobel 2016; Woolfson 2010).

Beyond its regional emphasis, *The Baltic Times* is a valuable resource for scholars, connecting local and global viewpoints on topics like information

warfare and hybrid crises (Denisenko 2020; Rislakki 2014; Schulze 2022; TBT Staff 2008). Through its consistent coverage of democratic transitions, economic development, and cultural integration, the newspaper provides insight into the adaptation of the Baltic states to an evolving global environment.

Important events in Baltic history from the period 1998–2024 have been covered by *The Baltic Times* on its website, such as NATO and EU accession (Staff and wire reports 2004), the global financial crisis of 2008–2009 (Turay 2008), and the increased security concerns after Russia's invasions of Georgia and Ukraine (BNS/TBT Staff (2022); TBT Staff (2008); Wire reports 2014). With an emphasis on sovereignty and adaptation, its coverage of these events demonstrates a dedication to documenting the Baltic states' strategic reactions and changing security position within a complex geopolitical environment (Bergmane 2020; Duvold, Berglund, and Ekman 2020; Mole 2012; Pettai 2021; van Ham 2013).

Therefore, as an international publication and mediator of regional developments, *The Baltic Times* both documents significant events for international readers and provides regional elites with perspectives on globally relevant issues. This bridging role makes it a significant resource for understanding how Baltic transformations, particularly in European integration and regional security, are conveyed to international stakeholders who are trying to comprehend the region's unique trajectory within the post-Soviet and European context.

Although the Baltic region and its media have been the subject of studies on democracy (Balčytienė, Bocullo, and Juraite 2024; Chakars and Ekmanis 2022; Jõesaar, Rožukalne, and Jastramskis 2022), security discourse (Bladaite and Šešelgytė 2022; Kuczyńska-Zonik 2023; Ventsel et al. 2021; Vihalemm and Juzefovičs 2022), and public opinion or economic perceptions (Balčytienė 2009a, 2009b; Donauskaitė 2022), there are surprisingly few long-term, thorough longitudinal analyses of *The Baltic Times'* coverage. Addressing this research gap could improve our comprehension of how regional and international perceptions of the Baltic states have changed, especially as *The Baltic Times* has documented their transition from post-Soviet republics to full EU and NATO members (Duvold and Berglund 2014; Duvold and Sedelius 2023; Mockutė 2008). This analysis shows how media coverage and themes adjust to geopolitical changes by placing English-language media within changing media ecosystems (Chakars and Ekmanis 2022; Jõesaar, Rožukalne, and Jastramskis 2022). The digital age has made advanced text and media analysis tools available, which have enabled researchers to process large text archives with unprecedented accuracy (Dehler-Holland, Schumacher, and Fichtner 2021; Ehrmann et al. 2023; Guo et al. 2016; Jacobi, Van Atteveldt, and Welbers 2018; Waila, Singh, and Singh 2013). Methods in natural language processing (NLP) such as topic modeling, Named Entity Recognition (NER), and sentiment analysis allow researchers to explore large datasets,

uncovering hidden thematic structures that would otherwise go unnoticed in traditional analysis (Nemes and Kiss 2021; Sandu et al. 2024; Thakuria and Deka 2024). These techniques are especially well suited for longitudinal studies in countries like the Baltic states, where long-term media coverage has changed in tandem with shifting political dynamics, growing security concerns, or regional integration initiatives.

By classifying topics and analyzing key named entities and media sentiment in Baltic English-language journalism, this study documents how *The Baltic Times* has chronicled themes of identity, European integration, and regional security through periods of significant change. Through computational analysis of news archives, this study contributes to our understanding of how Baltic developments have been presented to international audiences in broader European and global contexts.

This study uses topic modeling, NER, and sentiment analysis to examine *The Baltic Times* from 1998 to 2024. Specifically, we address the following research questions: Which themes emerge in *The Baltic Times*' coverage within this timeframe and how has their relative prominence evolved over time? How has the theme of geopolitical security and its coverage patterns changed throughout this period? Within the security-related theme, how have the representations and sentiments regarding key organizations, locations, and figures evolved? To answer these questions, we aim to identify and analyze the complete range of themes in the newspaper's discourse through topic modeling, examine the temporal patterns and trends in the security-related theme, and track the changes of significant entities within the security theme using NER and sentiment analysis.

Data and methods

We downloaded all 40,471 articles that were published between July 1998 and October 2024 on *The Baltic Times* website (<https://www.baltictimes.com/>). As indicated in Table 1, in order to make analysis easier, we divided these articles into distinct subsets according to the dates of publication. Several procedures were involved in data preprocessing to prepare the text for analysis. First, stop words – common words like 'and,' 'the,' and 'of' that do not help identify the topic – were eliminated. Lemmatization was then used to reduce words to their root or base forms, which guarantees consistency among related terms. Additional preprocesses included standardizing text cases and eliminating punctuation.

Recent transformer-based and conventional statistical-based methodologies are among the packages available for topic modeling (Abdelrazek et al. 2023; Chauhan and Shah 2021; Egger and Yu 2022). Transformer-based models work well for short texts, but they frequently have trouble reading long documents, like the extensive newspaper

Table 1. Number of articles published in *The Baltic Times*, 1998 to October 2024.

Year of publication	Number of files
1998	682
1999	1,089
2000	1,231
2001	1,159
2002	1,189
2003	1,271
2004	1,645
2005	1,731
2006	1,851
2007	1,812
2008	1,793
2009	1,621
2010	1,768
2011	1,783
2012	1,532
2013	1,426
2014	1,469
2015	1,217
2016	1,372
2017	1,451
2018	1,557
2019	1,824
2020	1,675
2021	1,560
2022	1,706
2023	1,669
2024	1,388
Total	40,471

pieces in our data (Zaheer et al. 2020). Because these models process input in smaller chunks rather than as a cohesive whole, they may face issues like high memory usage and have trouble capturing the overall context of lengthy texts (Ansar, Goswami, and Chakrabarti 2024; Bai et al. 2024; Beltagy, Peters, and Cohan 2020; Fournier, Caron, and Aloise 2023).

Furthermore, more than 400 topics were automatically allocated in our testing using transformer-based techniques like Top2Vec (Angelov 2020) and BERTopic (Grootendorst 2022). Such a large number of highly granular topics proved neither feasible nor operable for additional classification and analysis because they resulted in too many overlapping themes, excessive topic fragmentation, and substantially decreased interpretability.

For longer texts, Latent Dirichlet Allocation (LDA) tends to yield more manageable results (Albanese 2022; Bhangale 2023). Mallet, a popular LDA-based method that works well with larger documents, was our choice for this project (Blei 2012; McCallum 2002). The optimal number of topics in LDA remains one of the most challenging modeling parameters (Asuncion et al. 2009; Hagen 2018; Sbalchiero and Eder 2020; Wallach, Mimno, and McCallum 2009). While this methodological concern has been extensively discussed in

the literature, there is no universal consensus within the scientific community regarding the ideal approach to topic number selection (Bystrov et al. 2024; De Battisti, Ferrara, and Salini 2015).

The Topic Detection and Tracking (TDT) program was funded by the Defense Advanced Research Projects Agency (DARPA) in the 1990s. After extensive experimentation with the substantial Reuters news corpus, the project’s human experts determined that 25 topics would be the best way to cover the data (Allan, Papka, and Lavrenko 1998). In order to facilitate human analysis and comparison, this comparatively small value of topic number seemed practical. This realization led us to decide that 20 topics would be a manageable number for our investigation, which is approximately in line with DARPA’s advice.

As indicated in Table 2, we set up the MALLET LDA model (McCallum 2002) with certain settings to produce topic outputs. Three thousand iterations were chosen. In MALLET, the alpha and beta parameters were left at their default settings. The number of iterations between Dirichlet hyperparameter updates was specified by setting the optimize-interval parameter to 20. The document-topic and topic-word distributions are smoothed by the alpha and beta values, respectively. The alpha parameter determines how often a topic appears in a document, whereas the beta value affects how often a word appears in a topic. When optimization is enabled, the hyperparameters or their weights are adjusted dynamically, even though they are initially the same for all topics. After about 1,100 iterations, the samplers reached stability, according to the log-likelihood outputs from our testing procedure. In order to make the themes easier to understand and more relevant for analysis, we gave each theme a label based on the topic’s top keywords. Thereafter, we could more easily compare topics within the dataset and readily comprehend the main ideas that each topic represents thanks to this tagging.

It is noted that LDA, being a generative probabilistic model, generates topics without human intervention by automatically detecting patterns of word co-occurrences in the corpus (Blei 2012). Topics arise naturally from the texts rather than from preset categories since the model identifies statistical patterns of word usage that frequently occur together (DiMaggio, Nag, and Blei 2013). While we assigned interpretative labels to these found topics based on their most frequent output keywords for discussion and

Table 2. MALLET LDA configuration parameters.

Parameter	Value	Description
num-iterations	3000	Total number of Gibbs sampling iterations
optimize-interval	20	Interval (in iterations) for re-estimating Dirichlet hyperparameters
alpha	5.0	Smoothing parameter across topics for document-topic distribution
beta	0.01	Smoothing parameter for each topic-word distribution
num-topics	20	Total number of topics to generate

comparison, the underlying topic distribution is generated by the algorithm itself based on term frequency and co-occurrence. While the model may not always generate perfectly distinct categories, the analysis of word co-occurrences based on their computed most frequent keywords can outline patterns in how different issues were reported in the media coverage.

Newspaper articles frequently include important details on well-known people, places, and organizations. Finding these important entities within a sizable dataset offers information on the main topics and geographic emphasis of the media coverage. In order to achieve this, we used NER, a sophisticated natural language processing technology that automatically finds and classifies named items in text, including places, organizations, and individuals. As it enables us to methodically extract and categorize important elements, NER is useful for evaluating newspaper material and assisting in the comprehension of intricate storylines found within the articles. We used the spaCy package for NER, an effective NLP library respected for its accuracy and efficiency in entity recognition tasks (Honnibal et al. 2020). We were able to add context and depth to our analysis of the articles' content by methodically extracting mentions of organizations, places, and individuals using spaCy.

We used the Flair framework, an NLP library created by researchers at Humboldt University of Berlin, to better comprehend the sentiment and tone behind news coverage (Akbik et al. 2019). As Flair uses contextual embeddings to capture nuanced sentiment expressions in text, it is useful for sentiment analysis. We evaluated the emotional undertones in the news content by identifying the overall sentiment expressed in each piece using Flair's pre-trained sentiment model. We performed a thorough study of the articles by combining Flair for sentiment analysis, spaCy for NER, and Mallet's LDA for topic modeling. This multifaceted method gave us a more comprehensive perspective on the news data by enabling us to analyze not only the main themes but also the emotional tone and important entities of each piece.

Results and discussion

Understanding the larger societal framework is crucial before looking at the particular topic patterns. Despite each Baltic state's distinct journey, there are significant similarities in their respective post-Soviet evolutions. Mole (2012) emphasizes how elites in Latvia, Lithuania, and Estonia promoted a shared national identity. Within a few decades, they underwent not only similar post-socialist transformations as other eastern European nations but also experienced profound political and social changes by transitioning from being part of the Soviet Union to becoming members of the EU, NATO, and the Schengen Area (Zilinskiene, Kraniauskiene, and Ilic 2024). Lauristin and Vihailemm's two-decade study of Estonia's

development provides important insights into these regional processes. They identified key stages of Estonia's transition in their early work (Lauristin and Vihalemm 2002), which they later refined (Lauristin and Vihalemm 2009) to the following: breaking with the old system; radical reforms; economic stabilization and initial EU integration; EU accession preparations; and post-accession challenges.

In their most recent work, Lauristin and Vihalemm (2020) have developed their findings into a comprehensive morphogenetic framework of Estonian transformation through four major phases: the 'Singing Revolution' liberation movement (1988–1991); the reconstruction of the nation state through radical reforms (1992–2003); EU integration and adaptation (2004–2017); and the recent rise of populist counter-movements (2018–present). This framework was created through an analysis of Estonia, but it provides useful insights into how media coverage has evolved in tandem with more general societal shifts throughout the Baltic states, as all three nations faced comparable challenges with post-Soviet transformation, EU accession, and contemporary political dynamics. This provides a helpful lens for observing and comparing the trends in our topic study and allows us to place these observations within a broader framework of socio-political, historical, or economic developments.

Measures of topic specificity, coherence, and uniqueness among the dataset's topics are displayed in Table 3. A topic that appears in a large number of publications is less specific, according to higher values of document entropy. Greater negative values for coherence suggest that the topic terms do not frequently occur together, which may suggest topics that are less clearly defined. 'Uniform dist' quantifies how near a uniform distribution the topic distribution is, where greater values indicate less specificity. High uniform distribution distances for topics like Lithuanian Politics and Leadership (Topic 1), Estonian Government and National Affairs (Topic 0), and Latvian Governance and National Policy (Topic 4) indicate that they are less specific and more broadly dispersed throughout the data. Smaller values of 'corpus dist' suggest similarity and higher values suggest that the topic is different from the corpus vocabulary as a whole. The degree to which each topic's top words are unique is measured by exclusivity; lower values denote less exclusivity.

Topic 10 stands out with a high corpus distance, indicating that it may be more unique or specific to certain articles or a subtopic that is less related to the overall corpus vocabulary. Conversely, Topic 17 is obviously quite general and may overlap with several other topics due to its high document entropy, low corpus distance, and lowest exclusivity. Given their moderate exclusivity, high uniform distance, low coherence, and high document entropy, Topics 0 and 1 are broad or general. Given its high exclusivity value, Topic 3 appears to be more distinct and narrowly

Table 3. Diagnostic metrics output for topic model analysis.

Topic ID	Topic Label	Document entropy	Coherence	Uniform dist	Corpus dist	Exclusivity (Descending order)
3	Online Gambling and Digital Services	7.081	−266.222	4.822	1.839	0.633
6	Energy, Infrastructure, and Industry	8.313	−332.289	5.212	1.515	0.614
7	Public Health and Education	8.562	−340.594	5.196	1.608	0.560
15	Russian-Baltic Security and Geopolitics	8.805	−287.569	5.282	1.468	0.554
2	Urban Development and Transportation	8.426	−347.045	5.076	1.597	0.546
11	Crime, Law Enforcement, and Judicial Affairs	8.748	−296.301	4.818	1.592	0.531
19	Elections and Political Movements	8.548	−239.921	5.640	1.705	0.521
13	Arts, Culture, and Festivals	7.833	−235.613	4.492	1.669	0.521
10	Sports and International Competitions	7.565	−231.597	4.876	2.056	0.518
14	Historical Memory and Soviet Legacy	8.504	−340.112	4.585	1.654	0.499
1	Lithuanian Politics and Leadership	9.126	−370.342	5.931	1.842	0.462
18	Financial Markets and Economic Growth	8.422	−247.061	5.620	1.331	0.432
0	Estonian Government and National Affairs	9.151	−362.162	5.778	1.779	0.426
4	Latvian Governance and National Policy	9.207	−331.433	5.804	1.629	0.415
8	Business, Trade, and Market Trends	8.279	−270.658	5.072	1.578	0.401
12	Fiscal Policy and Public Finance	9.091	−303.363	5.248	1.193	0.336
5	European Union and Baltic Diplomacy	9.133	−258.989	5.324	1.273	0.323
9	Innovation and Economic Development	8.644	−260.599	4.926	1.215	0.304
16	Everyday Life, Media, and Leisure	8.533	−319.186	3.774	1.480	0.297
17	General National Issues and Social Dynamics	9.473	−281.660	4.410	0.989	0.234

focused than the others. As a result, whereas Topics 3 and 10 are more unique and specific, Topics 0, 1, and 17 are the most general, broadly relevant topics throughout the corpus.

A stacked area chart of topic weights from 1998 to 2024 is shown in Figure 1 and Table 4 lists all topic weights, labels, and top keywords. Using terms such as ‘estonian,’ ‘tallinn,’ ‘minister,’ and ‘government,’ Topic 0 (Estonian Government and National Affairs) highlights Estonia’s important role in regional news about the Baltics, especially when it comes to political changes. Using words like ‘lithuanian,’ ‘vilnius,’ and ‘president,’ Topic 1 (Lithuanian Politics and Leadership) highlights Lithuania’s governance and leadership. A key focus is Lithuania’s place within the EU and its political

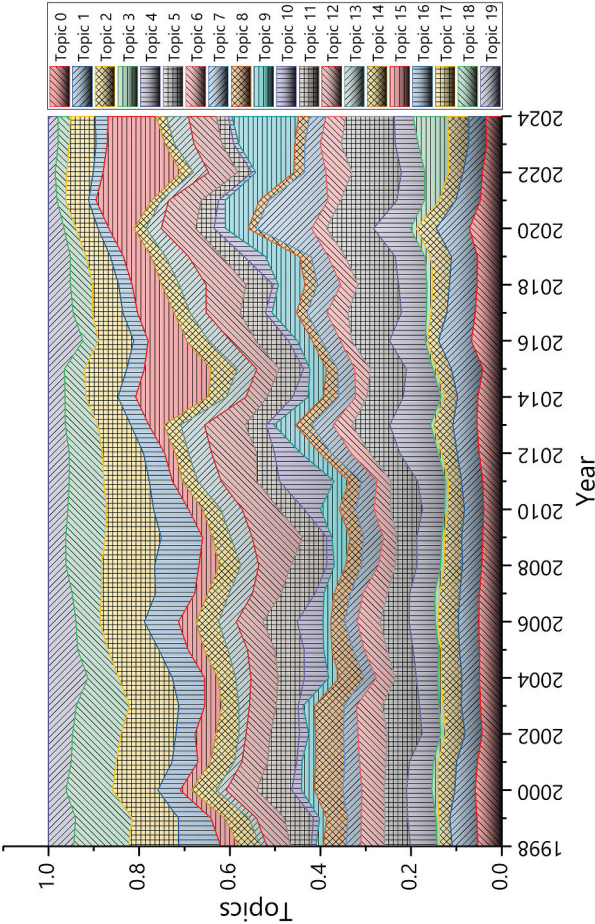


Figure 1. Stacked area chart of topic weights from 1998 to 2024.

Table 4. Topic weights, labels, and top keywords.

Topic_ID	Normalized Weights	Topic Label	Top 10 keywords (in descending frequency order)
0	5.982	Estonian Government and National Affairs	estonian, estonia, tallinn, estonias, minister, kroon, year, accord, tartu, government
1	6.060	Lithuanian Politics and Leadership	lithuanian, lithuania, vilnius, lithuanias, minister, president, country, state, lita, grybauskaite
2	3.736	Urban Development and Transportation	city, year, company, airport, riga, passenger, building, airline, construction, hotel
3	1.338	Online Gambling and Digital Services	casino, online, game, player, gambling, service, offer, payment, card, make
4	7.009	Latvian Governance and National Policy	latvia, latvian, riga, minister, latvias, government, state, lat, ministry, report
5	7.583	European Union and Baltic Diplomacy	european, country, foreign, minister, baltic, state, president, europe, union, member
6	3.105	Energy, Infrastructure, and Industry	energy, company, gas, oil, project, baltic, power, plant, rail, port
7	4.229	Public Health and Education	people, school, health, percent, education, year, student, child, university, number
8	3.081	Business, Trade, and Market Trends	company, market, product, year, million, percent, sale, price, food, production
9	5.225	Innovation and Economic Development	business, development, company, project, investment, technology, develop, work, service, market
10	1.623	Sports and International Competitions	team, game, win, world, sport, play, championship, olympic, club, basketball
11	4.781	Crime, Law Enforcement, and Judicial Affairs	police, court, case, investigation, criminal, prosecutor, crime, report, information, security
12	7.431	Fiscal Policy and Public Finance	government, state, budget, tax, law, euro, million, ministry, fund, pay
13	2.444	Arts, Culture, and Festivals	festival, art, music, exhibition, film, artist, concert, riga, event, year
14	4.053	Historical Memory and Soviet Legacy	soviet, people, russian, war, language, world, year, history, day, independence
15	5.092	Russian-Baltic Security and Geopolitics	russia, russian, ukraine, defense, nato, military, border, force, security, war
16	4.765	Everyday Life, Media, and Leisure	make, good, film, time, day, find, place, movie, people, life
17	13.569	General National Issues and Social Dynamics	time, people, country, make, baltic, year, good, work, problem, thing
18	4.715	Financial Markets and Economic Growth	percent, bank, million, share, year, euro, price, market, stock, baltic
19	4.178	Elections and Political Movements	party, election, parliament, vote, political, government, coalition, president, union, minister

environment, which includes figures like former Lithuanian President Dalia Grybauskaite (2009–2019).

In Topic 2 (Urban Development and Transportation), keywords like ‘airport,’ ‘riga,’ and ‘construction’ highlight city development, especially in Riga, as well as transportation infrastructure like air travel, reflecting trends in urbanization throughout the Baltics. Words like ‘casino,’ ‘game,’ and ‘online,’ which reflect the growth of online gambling throughout the Baltics, are used

in Topic 3 (Online Gambling and Digital Services), which focuses on the expanding digital economy.

In Topic 4 (Latvian Governance and National Policy), the terms 'riga,' 'minister,' and 'government' draw attention to Latvia's political climate and governmental initiatives, highlighting the crucial role that Latvian governance plays in Baltic affairs. Foreign policy, diplomatic ties, and EU membership are the main topics of Topic 5 (European Union and Baltic Diplomacy), which focuses on the Baltic states' EU membership and collaboration with European allies. Keywords like 'gas,' 'oil,' and 'power' highlight energy and infrastructure projects, notably the Rail Baltica project and Baltic energy independence, in Topic 6 (Energy, Infrastructure, and Industry).

Topic 7 (Public Health and Education) contains phrases like 'school,' 'health,' and 'education,' which highlight the main themes of public health and education in the region. This pattern of word co-occurrences would indicate that *The Baltic Times* appears to have covered public health and education issues as shared regional themes, rather than country-specific matters. Unlike the naturally occurring country-specific patterns in governance topics (Topics 0, 1, and 4), the algorithm with our set model parameters in this work detected that these sectors were more frequently discussed in a comparatively pan-Baltic way or context.

With phrases like 'company' and 'food,' which represent the Baltic economies' emphasis on exports and industry expansion, Topic 8 (Business, Trade, and Market Trends) discusses business markets, production, and exports. Technology and business development are highlighted in Topic 9 (Innovation and Economic Development). Words like 'technology,' 'investment,' and 'develop' imply an emphasis on innovation, especially in the Baltics' IT and digital industries. This trend significantly increases between 2022 and 2024. With its emphasis on 'sport,' 'team,' and 'world,' Topic 10 (Sports and International Competitions) highlights the Baltic states' involvement in international sports like basketball and the Olympics.

The phrases 'police,' 'court,' and 'crime' are used frequently in Topic 11 (Crime, Law Enforcement, and Judicial Affairs), which highlights criminal justice and law enforcement concerns. This reflects persistent concerns about public safety in the Baltics. Taxation, budgeting, and finance are the main themes of Topic 12 (Fiscal Policy and Public Finance), which also highlights debates over the Euro, funding, and payment.

The phrases 'festival,' 'music,' and 'film,' which are found in Topic 13 (Arts, Culture, and Festivals), highlight the cultural sector and allude to expanding arts industries, festivals, and international artistic cooperation. Terms like 'soviet,' 'independence,' and 'history,' which reflect continuing conversations about history and national identity, are used in Topic 14 (Historical Memory and Soviet Legacy) to analyze post-Soviet experiences. Topic 15 (Russian-Baltic Security and Geopolitics) focuses on 'russia,' 'nato,' and 'military,'

emphasizing security issues and the strategic significance of the Baltic nations in NATO.

With its focus on ‘film,’ ‘people,’ and ‘life,’ Topic 16 (Everyday Life, Media, and Leisure) highlights media, culture, and everyday life in the Baltics, especially through media reporting or cinema. Topic 17 (General National Issues and Social Dynamics) is the most popular topic (13.57%). It covers a broad spectrum of social topics, ranging from politics to social transformation. The integration of Baltic economies into international markets is reflected in Topic 18 (Financial Markets and Economic Growth), which focuses on finance, investment, and stock markets. With terms like ‘election,’ ‘parliament,’ and ‘vote’ concentrating on political processes and changes, including the rise of populist movements, Topic 19 (Elections and Political Movements) emphasizes electoral dynamics.

Key aspects of the post-Soviet transition in the Baltic states are reflected in the emergence of these topics. The governance topics (Topics 0, 1, and 4) describe the institutional development of each Baltic state, which corresponds to the reconstruction as defined by Lauristin and Vihalemm (2020). According to their identified phase of EU integration and adaptation, EU-related topics (Topic 5) are prominent. Meanwhile, security concerns (Topic 15) reflect what Lauristin and Vihalemm (2020) state as the securitization of the Baltic states: a steadfast focus on security issues that intensified even after EU and NATO membership.

Regression analysis was also performed on the topic weights between 1998 and 2024 (Table 5). Topics 3, 5, 7, 9, 13, and 15 have statistically

Table 5. Linear regression parameters for topic weights from 1998 to 2024.

Topic_ID	Coefficients	P-value
0	0.000	0.519
1	0.000	0.203
2	0.000	0.546
3	0.001	0.001
4	0.000	0.253
5	0.003	0.000
6	−0.001	0.013
7	0.001	0.013
8	−0.002	0.000
9	0.003	0.000
10	0.000	0.673
11	−0.001	0.001
12	0.000	0.288
13	0.001	0.006
14	−0.001	0.000
15	0.004	0.000
16	−0.002	0.000
17	−0.003	0.000
18	−0.004	0.000
19	−0.001	0.001

significant increases, according to the topic trends analysis. These point to an increase in conversations about innovation, public health, security, EU diplomacy, and cultural endeavors. This is in line with the Baltics' development into contemporary EU nations, their concerns about Russian influence, and the significance of social services in the wake of the COVID-19 epidemic. Topics 15 and 9 have comparatively larger increases.

Declining interest in Soviet history, traditional energy, crime, and elections is reflected in downward trends in Topics 6, 8, 11, 14, and 16–19. This implies a move away from historical legacies and domestic problems and toward matters that are more focused on the future, such as technology and international relations. Topics 17 and 18 have greater declines in comparison. The decline in Soviet legacy issues (Topic 14) and increase in EU diplomacy, innovation, and security topics (Topics 5, 9, and 15) reflect what Lauristin and Vihalemm (2020) describe as a fundamental transition from post-Soviet reconstruction to European integration. This suggests that broader societal transformation processes were chronicled in media coverage.

Russian-Baltic security and geopolitics

A closer look shows that between 1998 and 2010, Topics 17 and 18 alternated as the largest topics, whereas Topics 3 and 10 continuously remained the smallest topics in the long run (Table 6). The most notable periods for Topic 15 are 2014–2016 and 2022–2023. Since 2013, this topic has grown significantly, which reflects increased regional tensions and a desire for security as a result of military events or action. The spike highlights the Baltic states' priority on defense cooperation with NATO to strengthen regional security and their response to perceived threats.

We discovered significant movement after closely examining the top 10 articles of Topic 15 with the greatest weights annually from 2012 to 2014 (Table 7). With titles that highlight military advancements and diplomatic initiatives without panicking or catastrophizing, the articles from 2012 primarily show a careful approach to security issues. Articles from 2013 show a marked shift in tone toward increased security worries, with a growing fear over Russia's military objectives. Titles like 'Baltic leaders express fears over Russia missile plans' (17 December 2013) convey a clear threat. The pivotal year of 2014 was marked by articles about direct conflicts and military readiness. Titles like 'NATO ships on the way to Baltics' (18 April 2014) and 'U.S. to send troops to Baltics for war games' (14 August 2014) show a definite increase in military preparedness and global engagement. Topic 15's shift from 2012 to 2014 illustrates a significant shift in the security environment of the Baltic states. This development demonstrates how outside events influence perceptions of regional security.

Table 6. Topics with largest and smallest weights.

Year	Largest weight		Smallest weight	
	Topic ID	Topic Label	Topic ID	Topic Label
1998	18	Financial Markets and Economic Growth	3	Online Gambling and Digital Services
1999	18	Financial Markets and Economic Growth	3	Online Gambling and Digital Services
2000	18	Financial Markets and Economic Growth	3	Online Gambling and Digital Services
2001	17	General National Issues and Social Dynamics	3	Online Gambling and Digital Services
2002	17	General National Issues and Social Dynamics	3	Online Gambling and Digital Services
2003	18	Financial Markets and Economic Growth	3	Online Gambling and Digital Services
2004	17	General National Issues and Social Dynamics	3	Online Gambling and Digital Services
2005	17	General National Issues and Social Dynamics	3	Online Gambling and Digital Services
2006	17	General National Issues and Social Dynamics	3	Online Gambling and Digital Services
2007	17	General National Issues and Social Dynamics	3	Online Gambling and Digital Services
2008	17	General National Issues and Social Dynamics	3	Online Gambling and Digital Services
2009	17	General National Issues and Social Dynamics	3	Online Gambling and Digital Services
2010	17	General National Issues and Social Dynamics	3	Online Gambling and Digital Services
2011	10	Sports and International Competitions	3	Online Gambling and Digital Services
2012	12	Fiscal Policy and Public Finance	3	Online Gambling and Digital Services
2013	4	Latvian Governance and National Policy	3	Online Gambling and Digital Services
2014	15	Russian-Baltic Security and Geopolitics	3	Online Gambling and Digital Services
2015	15	Russian-Baltic Security and Geopolitics	3	Online Gambling and Digital Services
2016	15	Russian-Baltic Security and Geopolitics	3	Online Gambling and Digital Services
2017	5	European Union and Baltic Diplomacy	3	Online Gambling and Digital Services
2018	5	European Union and Baltic Diplomacy	10	Sports and International Competitions
2019	5	European Union and Baltic Diplomacy	3	Online Gambling and Digital Services
2020	7	Public Health and Education	3	Online Gambling and Digital Services
2021	7	Public Health and Education	10	Sports and International Competitions
2022	15	Russian-Baltic Security and Geopolitics	10	Sports and International Competitions
2023	15	Russian-Baltic Security and Geopolitics	10	Sports and International Competitions
2024	9	Innovation and Economic Development	10	Sports and International Competitions

Table 7. 2012–2014 top 10 article titles of topic 15 with the largest weights.

Year	Article title	Topic 15 non-normalized weights
2012	2012_Lithuania_Allied_landing_demonstrates_crisis_response_efficiency	0.757
	2012_Mar_EU_agrees_on_new_sanctions_against_Belarus_and_Syria	0.645
	2012_Aug_Raklevicius_assumes_Air_Base_command	0.642
	2012_Jan_Dona_t_Forget_Europe_II	0.588
	2012_News_briefs_BalticTimes_Estonian_government_approves_of_extending_foreign_missions	0.574
	2012_Apr_Estonia_carefully_observes_military_developments_in_Russia	0.522
	2012_May_Chicago_Summit_delivers_wish_list	0.501
	2012_Jun_Defense_cooperation_rules_eased	0.486
	2012_Jul_Yawning_while_Russia_army	0.479
	2012_Estonia_Europe_threatens_its_future_security	0.478
	2013_Dec_Russia_has_not_placed_missiles_in_Kaliningrad_says_Putin	0.900
	2013_Dec_Baltic_leaders_express_fears_over_Russia_missile_plans	0.823
	2013_Sep_Baltics_a_concerned_a_over_Russia-Belarus_war_games	0.790
2013	2013_Top_stories_War_games_send_right_signals_says_NATO_chief	0.778
	2013_Top_stories_Major_war_games_come_to_Baltics	0.758
	2013_Oct_Sweden_to_join_major_military_exercises_in_Latvia	0.738
	2013_Dec_Lithuania_defense_chief_meets_troops_in_Afghanistan	0.727
	2013_Lithuania_Baltics_concerned_over_war_games	0.708
	2013_Top_stories_Estonia_sends_150_troops_to_Afghanistan	0.694
	2013_Opinion_Time_to_end_the_aggression	0.681

(Continued)

Table 7. (Continued).

Year	Article title	Topic 15 non-normalized weights
2014	2014_Aug_U_S_to_send_troops_to_Baltics_for_war_games	0.938
	2014_Jun_Russia_in_tit-for-tat_military_exercises	0.937
	2014_Apr_NATO_ships_on_the_way_to_Baltics	0.935
	2014_Nov_US_troops_to_stay_in_Poland_Baltics_until_2015	0.916
	2014_May_Russia_now_an_adversary_says_NATO	0.915
	2014_Aug_Canada_sends_fighter_jets_to_patrol_Baltic_skies	0.901
	2014_Aug_Lithuania_cites_reports_of_Russian_military_equipment_crossing_into_Ukraine	0.897
	2014_Nov_Russian_troops_moving_towards_ceasefire_line_in_Ukraine_warns_NATO_chief	0.889
	2014_Nov_NATO_to_extend_air_policing_in_Baltic_states_amid_Russia_tensions	0.887
	2014_Apr_Russian_planes_encroach_upon_Latvian_airspace	0.883

Since military spending is the most straightforward, clear, and measurable policy response to security concerns, a comparison of media coverage of security issues with military expenditure data is especially pertinent. Through this comparison, we may investigate whether the actual policy changes and resource allocation decisions made by regional governments align with increased or decreased media coverage (as measured by Topic 15 weights). The comparison can also show, from a quantitative standpoint, whether and how media reporting and concrete defense strategies evolve in tandem.

We examined the Stockholm International Peace Research Institute (SIPRI) Military Expenditure Database data (2024) for Estonia, Latvia, and Lithuania from 1998 to 2023 in terms of military spending as a percentage of GDP. As a proportion of GDP, all three Baltic states exhibit an upward tendency, with Figure 2 showing a particularly noticeable rise beginning around 2014. Estonia continuously maintained a larger share of military spending than Latvia and Lithuania between 1998 and approximately 2013. There has been a noticeable change in the priorities for military spending since 2014. Between 2014 and 2023, Estonia's share increased progressively from 1.93% to 2.87%. Lithuania and Latvia also exhibited notable rises. Lithuania in particular has seen a significant increase in recent years, rising to 2.72% in 2023, possibly as a result of increased security concerns and its close proximity to Russia. The data shows that, especially after 2014 and more significantly after 2022, the Baltic states made a strategic move toward higher defense spending.

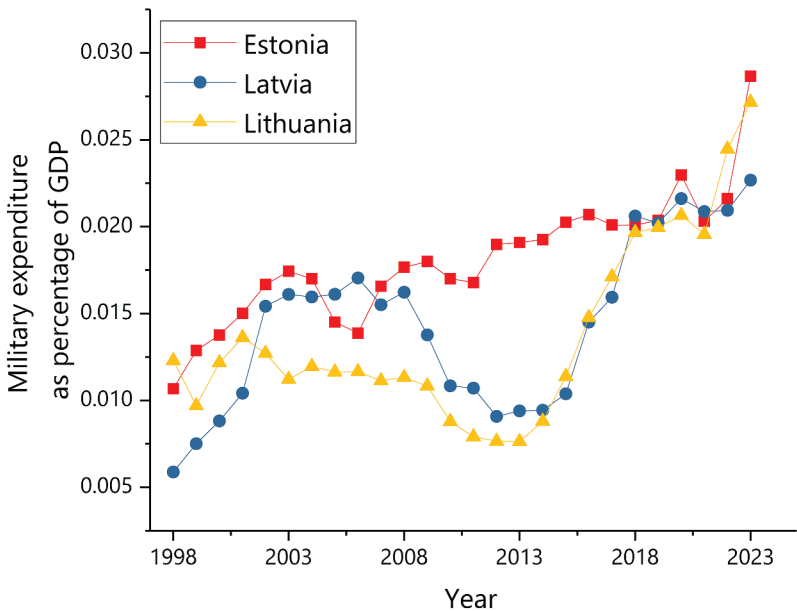


Figure 2. Military expenditure as a percentage of GDP for the three Baltic states (1998–2023).

Using the SIPRI information, we calculated combined annual military expenditures for 'Eastern_Europe,' 'Western_Europe,' and the three Baltic states between 1998 and 2023. We then compared these figures with the Topic 15 weights. For 'Eastern_Europe,' military spending increased steadily starting in 1998 and then more significantly after 2013 (Figure 3), particularly in the most recent years (2021–2023). The increase in Topic 15 weights is consistent with this. Much like 'Eastern_Europe,' military spending in the three Baltic states also grew steadily, particularly after 2013, with substantial growth by 2022 and 2023. Increased security responses in the Baltic region are indicated by the sharp increase in spending, which is consistent with the rise in Topic 15 weights. In 'Western_Europe,' military spending is relatively stable but shows a gradual increase, particularly from 2020 onward.

Strong positive relationships between Topic 15 weights and military spending in the Baltic states and 'Eastern_Europe' are found using the Spearman correlation test (Table 8). This shows that 'Eastern_Europe' and the Baltic states increased their military spending in response to regional challenges and the escalation of security concerns (Topic 15). 'Western_Europe' does not display a similar pattern, indicating different regional priorities or responses to Topic 15-related security concerns.

We examined the 5,000 articles in Topic 15 with the greatest weights using NER (organization) analysis. According to this examination, the most frequently referenced organizations over time are NATO, EU (European

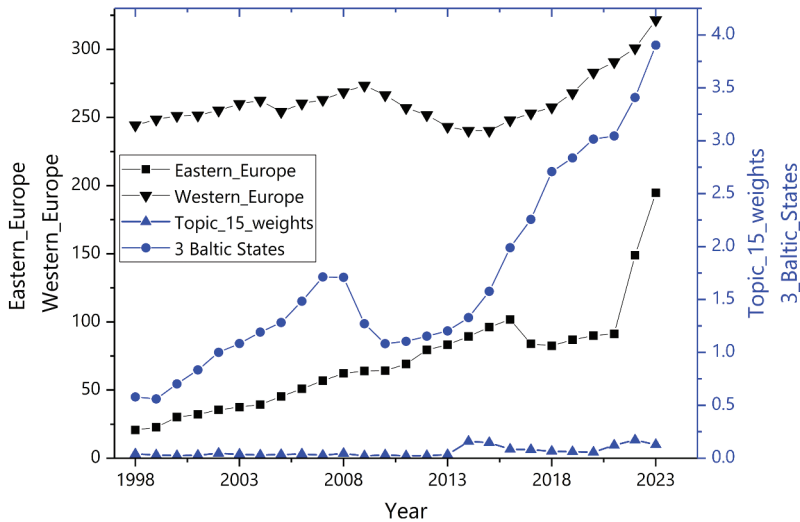


Figure 3. Topic 15 weights and military expenditures (in billion us dollars) for eastern Europe, western Europe, and the three Baltic states from 1998 to 2023.

Table 8. Spearman correlation between topic 15 weights and military expenditures in different European regions (1998–2023).

	Parameter	Eastern_Europe	Western_Europe	3_Baltic_States
Topic_15 weights	Spearman Corr.	0.660	0.076	0.666
	p-value	0.00023	0.71374	0.00021

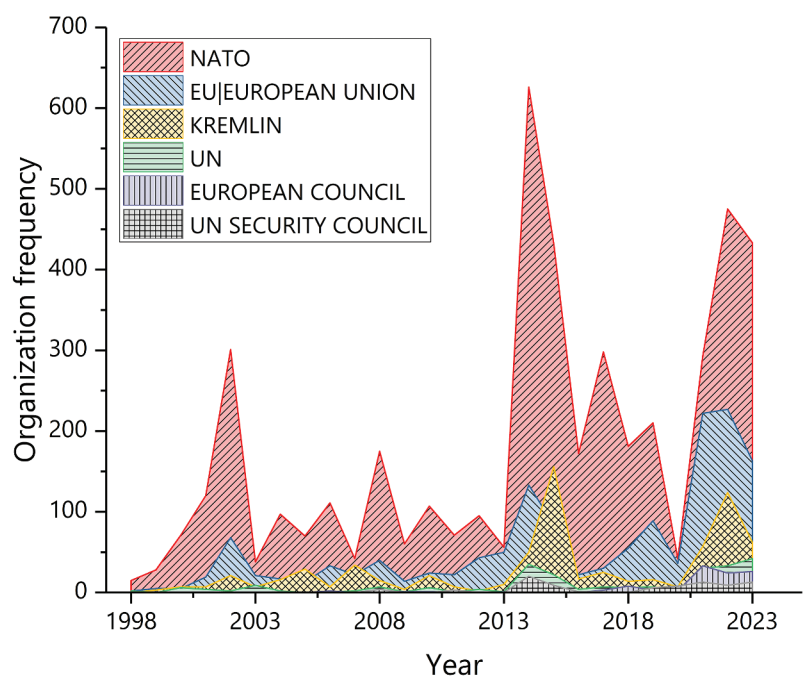


Figure 4. Frequency of top-mentioned organizations in the 5,000 articles with the highest topic 15 weights.

Union), Kremlin, UN, European Council, and UN Security Council (Figure 4). The number of NATO mentions varies with time, with noticeable increases beginning in 2014. The mention peaks in 2022, 2023, and 2014, which most likely represents heightened alliance activity and military deployment in reaction to regional concerns. In contrast to NATO, the EU exhibits a steady but less noticeable increase. In times of heightened geopolitical tensions, particularly around the 2014 and 2022–2023 peaks, the EU mentions see a moderate rise.

There is a noticeable increase in mentions of the Kremlin, especially after 2014. Its resurgence in 2022 appears to be related to the Russian invasion of Ukraine. To a lesser degree, the European Council and the UN also refer to the war. The European Council is mentioned more frequently from 2021 onwards. The UN is also mentioned frequently, which reflects its involvement in

international peacekeeping missions. Though infrequently discussed, the UN Security Council peaks in 2014, 2021, and 2023, which reflects international security debates about Russian dominance and the Baltic region.

Given the Baltic region's strategic sensitivity to Russian military and political actions, these tendencies imply that *The Baltic Times'* coverage of these organizations is extremely responsive to geopolitical developments, particularly those involving NATO and the Kremlin. Russia is the most often cited location in the top 12 NER location analysis of the 5,000 articles, with notable surges in 2002, 2008, 2014, and 2022 that coincide with regional events and escalations, including the 2008 Russo-Georgia war (Figure 5). Due to security concerns, the Baltic countries' involvement has been steadily increasing since 2014.

The newspaper's focus on regional instability is shown in the surge in mentions of Ukraine, Georgia, and Afghanistan during the periods in which these countries were involved in wars. Periodically, Western allies like the US, Germany, and Poland are mentioned, which highlights the Baltic region's support for NATO and Western security objectives, especially in light of growing concerns about Russia. This analysis demonstrates how *The Baltic Times'* media coverage is influenced by geopolitical events, with a particular emphasis on alliances and territories that are vital to Baltic security.

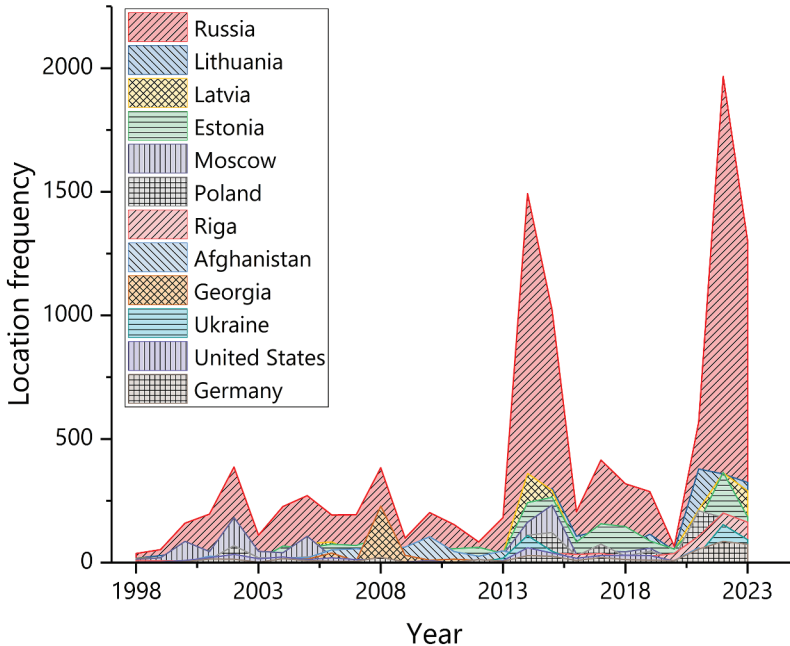


Figure 5. Frequency of top-mentioned locations in the 5,000 articles with the highest topic 15 weights.

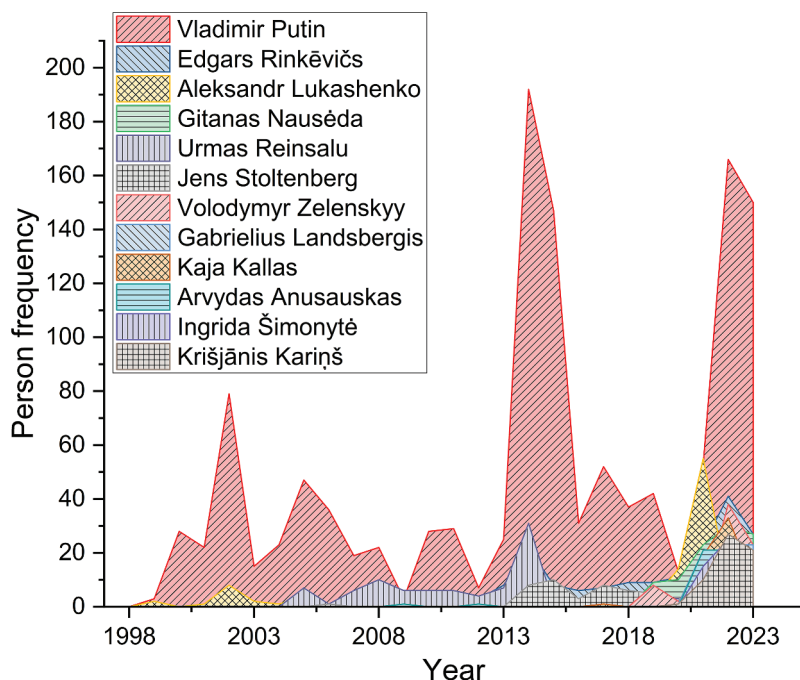


Figure 6. Frequency of top-mentioned persons in the 5,000 articles with the highest topic 15 weights.

Key figures in Baltic and eastern European geopolitics are revealed by the top 12 individuals determined by NER person analysis of the 5,000 articles (Figure 6). Vladimir Putin is cited the most often, particularly in periods of regional crisis, which highlights his influence on security issues in the Baltics. Edgars Rinkēvičs makes frequent appearances, which is indicative of his significant position in regional diplomacy. Gitanas Nausėda's leadership amid regional tensions has been highlighted by an increase in recent years. Aleksandr Lukashenko is also frequently mentioned. For his defense and international policy efforts, particularly in reaction to Russian moves, Urmas Reinsalu is among the most frequently mentioned people in the 5,000 articles. The inclusion of NATO Secretary General Jens Stoltenberg highlights the alliance's significance for Baltic security, while Volodymyr Zelenskyy is increasingly mentioned in the wake of Russia's 2022 invasion of Ukraine.

Other highly cited figures include Gabrielius Landsbergis, Kaja Kallas, Ingrida Šimonytė, Arvydas Anusauskas, and Krišjānis Kariņš, which reflects the Baltic leaders' consistent responses to security crises and ongoing involvement in alliances and defense.

In conclusion, security, regional diplomacy, and reactions to geopolitical pressures are consistently highlighted in the NER analysis of the organizations, places, and individuals in the 5,000 articles. The region's concerns about sovereignty and alignment with Western powers are highlighted by important institutions like NATO and the EU, well-known places like Russia and the Baltic nations, and significant personalities like Vladimir Putin and Baltic politicians. *The Baltic Times'* function in chronicling the Baltic region's tenacity and strategic positioning in the face of changing political and security environments is reflected in this research.

From 1998 to 2024, *The Baltic Times'* sentiment scores for the 5,000 articles with the greatest Topic 15 weightings exhibit a fluctuating trend that reflects shifting perspectives on regional security and geopolitical developments (Figure 7). The sentiment scores from 1998 to 2008 are primarily negative, which reflects widespread feelings of worry or apprehension regarding Russian–Baltic relations or security. Negativity peaks are seen around 1999, 2003, and 2005, which indicates that tensions were higher throughout these years.

From 2009 to 2013, sentiment evens out, with certain years like 2009, 2010, and 2012 even displaying a modicum of optimism. This can reflect diplomatic efforts or feelings of relative stability. When the crisis in the region began in

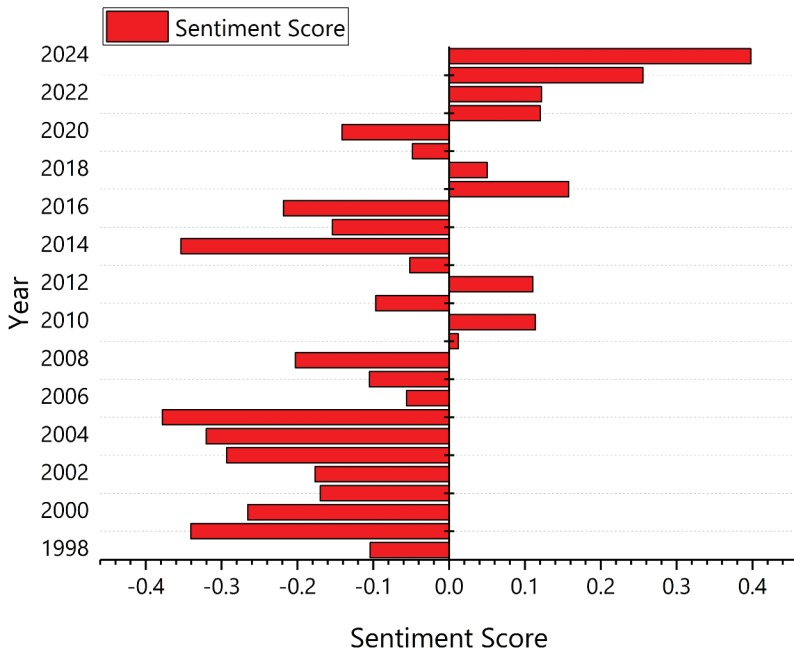


Figure 7. Sentiment scores for the 5,000 articles with the highest topic 15 weights.

2014, sentiment fell precipitously, raising security fears in the Baltic region. Overall sentiment in 2015–2020 is still negative but somewhat mixed, but less so than in 2014; this suggests continued caution without the extreme negativity of previous years.

Positive sentiment takes over in 2021–2024, steadily rising each year and peaking in 2024. The Baltic states' geopolitical posture may have shifted toward greater optimism as a result of this, which possibly reflects strengthened partnerships through NATO's heightened presence and other strategic advancements. Alternatively, this evolution in sentiment might indicate a rise in trust in the Baltics' defensive capabilities and the efficiency of global security agreements. It is possible that *The Baltic Times'* increasingly optimistic coverage of security-related issues reflects a change in the way the region's strategic position is regarded both at home and abroad. Overall, the sentiment data shows how the Baltic region's view of security in relation to Russia has changed over time, shifting from high apprehension in the past to cautious optimism in the present.

Conclusion

This study shows how media coverage and themes in the Baltic region have changed over time by offering a comprehensive, data-driven analysis of *The Baltic Times* between 1998 and 2024. We have identified the main themes influencing the English-language media discourse in the Baltic states using sophisticated natural language processing techniques, such as topic modeling, NER, and sentiment analysis. These findings show how important socio-political and economic events have been represented in the media, especially in relation to the Baltic states' increasing digital landscapes, reactions to geopolitical issues, and integration into European institutions. Based on overall weights, the data shows that social dynamics, EU and Baltic diplomacy, finance, governance in the three Baltic states, innovation, and Russian-Baltic security and geopolitics are the most popular themes. Conversely, topics like sports, energy and industry, online gambling, and the arts and culture have received the least attention.

The analysis reveals significant and underlying trends over time. In line with the region's growing emphasis on security, technological growth, and social development, topics like Russian-Baltic security and geopolitics, innovation, EU and Baltic Diplomacy, and public health and education have gained prominence. The Baltic states' strategic reaction to local security problems, particularly in the wake of important events in the region, is highlighted by the increased coverage of Russian-Baltic security and geopolitics. Notable spikes in coverage of this topic occurred between 2014 and 2016 and between 2022 and 2023, which coincided with higher military spending and

NATO partnerships and highlighted the Baltic region's changing defense posture.

Conversely, coverage of topics such as finance, social dynamics, historical memory, and the Soviet legacy has decreased, which suggests a shift away from historical and traditional issues toward more forward-looking topics like security, innovation, and international relations. These trends reflect a broader change in *The Baltic Times*' reporting focus, moving from historical themes to discussions of strategic positioning and international collaboration.

These findings align roughly with the broad morphogenetic framework of Baltic change that has been proposed by Lauristin and Vihalemm (2020), particularly regarding the transition from reconstruction to EU integration. The topic analysis illustrates how *The Baltic Times* documented this shift by placing less emphasis on historical memory and more on EU diplomacy. The transformation of the Baltic nations into Europe's frontline, as noted by Major and von Voss (2016), and a significant inflection point, as observed by Crowther (2023), are reflected in the media's focus on security. *The Baltic Times* has served as a consistent chronicler of regional developments for international audiences.

Unlike earlier studies, this work complements the frameworks of Lauristin and Vihalemm (2020) by providing measurable, topic-based, and time-specific evidence of changes in media coverage. In addition to identifying the changes in Baltic media coverage, our computational approach specifies exactly when and to what extent these changes occurred. This data-driven perspective contributes to the validation and extension of earlier studies on Baltic change by offering concrete metrics for thorough, multi-faceted analysis and practical comparison.

Our additional computational linguistics methods enrich topic modeling analysis. By identifying key organizations commonly cited in the articles – such as NATO, the EU, Russia, and the Baltic states – the NER analysis of the topic 'Russian-Baltic Security and Geopolitics' effectively enhanced the study. The region's emphasis on security, strategic alliances, and responses to geopolitical challenges was underscored by the frequent naming of notable individuals, including Vladimir Putin, Baltic leaders, and Jens Stoltenberg. This discovery emphasizes how *The Baltic Times* serves as a window into the geopolitical priorities of the area.

Sentiment study of the topic Russian-Baltic Security and Geopolitics revealed a dramatic shift in the tone of *The Baltic Times*' coverage, from initial wariness in early years, through periods of mixed evaluations, to a more measured and proactive position in recent years. These changes are in line with the Baltic's evolving security goals and the increasing focus on regional stability and defense cooperation in response to local

security developments. The sentiment trends show how *The Baltic Times*' tone transformed in its reporting of regional security issues.

Despite providing a longitudinal, quantitative, and topical approach to understanding Baltic media coverage, this study has certain drawbacks. Reliance on English-language sources may not fully capture the subtleties found in regional media, which could offer a more comprehensive understanding of the region. Future research should expand upon this work by integrating multilingual datasets and exploring additional media formats, such as social media, podcasts, and emerging platforms, which are becoming increasingly influential in communication. Furthermore, as geopolitical contexts continue to evolve, future studies could examine how Baltic media adapts to emerging global trends and provide a more thorough understanding of the region's strategic orientation and cultural integration.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Declarations

The source data analyzed in this study are publicly available from *The Baltic Times* (<https://www.baltictimes.com/>). The processed data generated during the analysis are available from the corresponding author upon reasonable request. The data were used solely for noncommercial academic research and analysis. All authors declare that they have no competing interests.

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