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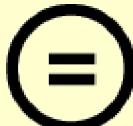
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Master's Thesis of Engineering

# News Snapshot: Design for Enhancing News Reading Experience Using Semantic Sentence Analysis

뉴스 스냅샷: 시맨틱 문장 분석을 통한 뉴스  
독자의 경험 향상을 위한 디자인

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# News Snapshot: Design for Enhancing News Reading Experience Using Semantic Sentence Analysis

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## Abstract

This research introduces a novel news system to address the problems posed by the brevity, lack of depth, and overwhelming volume of news articles in the digital media landscape, driven by the rapid advancements and shifts in news consumption habits.

The system, named "News Snapshot," was designed to help news readers easily understand the core content of a news story and the progression of an issue. News Snapshot captures the key points from multiple news articles covering the same event and presents them to the reader concisely and informally. It visualizes key content according to the timeline of an ongoing issue, allowing users to get a sense of the evolution of an issue quickly. The system utilizes sentence embedding and clustering methods to find key content in a collection of news articles.

We conducted an experiment with 22 participants to validate the effectiveness and usability of our system, comparing it to a control interface. The results showed that the system eases the process of reading news articles and helps identify an issue's main points. In the final section of the paper, we discussed the possibilities and limitations of News Snapshot and suggested how our method can be utilized in various fields.

**Keyword :** Intelligent system, Online news interface, News reading experience

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# Chapter 1. Introduction

## 1.1. Study Background

There have been various changes in news delivery and consumption patterns due to the advancement of digital media and changes in the news industry. The use of social media for news has increased significantly[1][2][3]. Despite these changing news trends, the demand for online text-based news articles remains high [4]. Reading news articles is the easiest and fastest classic approach to accessing news, offering control over the speed and volume of information. It is also preferred when internet quality is poor. Online news has added real-time elements to news, leading to shorter publishing cycles and increased articles [5]. This shift has led to challenges, such as the articles' brevity or lack of depth. Furthermore, the sheer volume of available news articles can be daunting, often causing readers to experience information overload and, in some cases, leading to avoidance of news altogether [6][7].

Numerous prior studies have been conducted to identify and communicate topics in news articles to help users quickly understand the news content. However, these studies primarily focused on conveying news trends based on categories or delivering information using a keyword-based approach. While these approaches help understand the overall distribution of news articles, they do not help understand the content and flow of news stories by issue.

In this context, there is a need for methods to improve the news reading experience. Presenting the main content of the many news articles about the same event can lessen the readers' burden, and delivering the context of the issue can help them understand the content better.

## 1.2. Purpose of Research

This research proposes a novel news system to alleviate the issues of article brevity, lack of depth, and the overwhelming volume of news articles resulting from the rapid evolution of digital media and shifting news consumption patterns. Our system, 'News Snapshot,' was designed to help readers quickly grasp the issue's main points without spending significant time on extensive reading. The system extracts the subtopics of an issue by clustering sentences from multiple articles about the same issue and displays them in chronological order as a timeline.

This study was conducted based on the following primary research questions:

**RQ1: Can our system assist in identifying the key content of redundant news articles?**

**RQ2: Can our system help users understand the context of issues as they evolve over time?**

By addressing these questions, we aimed to enable people to efficiently obtain information about an event and easily comprehend the progression of an issue.

To validate the effectiveness and usability of our system, we conducted an experimental study with 22 participants. We developed a control interface similar to an existing news aggregator service for comparison purposes, allowing us to evaluate our system's performance and user experience. The results of the study showed that our system simplifies the process of reading news articles and helps to identify the main points of a news story.

## Chapter 2. Literature Review

### 2.1. Evolving News Industry and Consumption Trends

The evolution of digital media and the transformation of the news industry has led to significant changes in how news is delivered and in the news consumption patterns of readers. Major methods of news consumption now include news websites and apps, search engines, social media, podcasts, news aggregators, and email newsletters. Among these, the proportion of news access through social media has been rising significantly [1][2]. The convenience of discovering news while using services like social media dramatically influences the preference for news videos. Video-based content has now emerged as a significant medium for news [1][5][8]. The preference for online news viewing is due to its accessible and engaging format.

However, the consumption of text-based news online still predominates despite the growing consumption of news video content through social media [5]. The reasons for readers favoring reading over watching online news are varied. The primary reason is that reading provides the fastest access to required information. Also, reading offers more control than playing videos. Poor video experiences due to slow internet speeds make reading text-based news articles the best choice. Consequently, efforts to enhance the consumption experience of text-based news content are necessary.

Online news delivery has enabled real-time information sharing on events, and the absence of time constraints in breaking news has allowed people to learn about and respond to ongoing situations quickly. However, this style of news reporting has led to disengagement due to the brevity or lack of depth in articles, particularly when participants wish to extend their existing knowledge of an issue [14][15]. News readers often found it difficult to grasp the main content and the evolution of an event from a single news article,

requiring them to search for multiple previous articles to understand the context of an issue [15].

The design limitations of online news delivery systems were not particularly efficient at enhancing the effectiveness of news reading. Traditional news systems often display news in a dashboard or list format, where content is arranged by the publication time (placing the newest articles at the top) or by rules like the number of clicks. Such layouts frequently lead to a screen filled with numerous short articles or breaking news about the same event. News Aggregators like Google News and Naver News group similar news articles into 'Headlines' categories. However, there is no comprehensive analysis of what is being discussed across news articles within a 'Headlines'. Additionally, unfriendly article search interfaces and the complexity of organizing issue content inconvenience users.

Therefore, there is a need to study on methods and interfaces that can extract the main content of multiple news articles about the same event and deliver it to readers in chronological order to improve the news reading experience. In Section 2.2, we introduce prior work on extracting and visualizing topics from news content. Section 2.3 presents previous work on methods and interfaces for displaying time-based changes in news content.

## 2.2. Topics in News Content

Several studies have utilized various algorithms and techniques to extract topics from news content, including keyword-based, LDA(Latent Dirichlet Allocation), and clustering-based methodologies [16][17]. However, the output of these methods is mostly word-based, which limits their ability to fully capture the complexity or nuances of a document. Various visualization methods have been studied to quickly and easily convey the main content of a document to users; however, these visualizations are mostly word-based, making it difficult to understand the context of the topic.

One of the simplest methods to visualize topics is through word clouds [19], which display words from a document, mapping their font size according to their weight (typically frequency) [17][20][21] [22]. WCLOUDVIZ [17] is an example of a word cloud visualization (Refer to Figure 1). WCLOUDVIZ utilized LDA for classifying Indonesian news articles, visualizing keywords in each news category as word clouds. TextArc [20], a modified word cloud, displays the text of a document. It highlights frequently used keywords. Figure 2 is a TextArc visualization of Alice's Adventures in Wonderland.



Figure 1: WCLOUDVIZ. The figure represents the visualization of key words in news categories using word clouds [17].

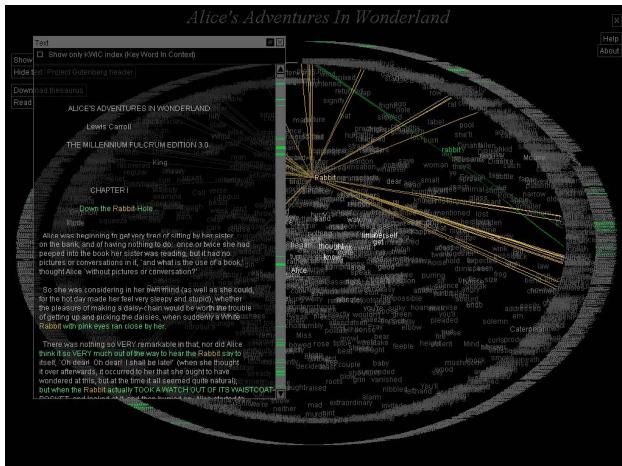


Figure 2: TextArc. A word cloud form that shows relationships between words by applying edges between related words [20].

In a word cloud visualization, it is often difficult to notice small-sized words because more important words appear much larger, and

less critical words appear relatively smaller. In addition, word cloud visualizations do not show the full context because they rely on words alone [23].

In traditional word clouds, words that convey the same meaning but have different forms are treated as separate entities, giving an inaccurate representation of the importance of words. There have been attempts to solve this problem by using word embedding or applying hierarchies between words to capture the semantic meaning of a document. Figure 3 shows a semantic word cloud created using word embedding[24]. Instead of sizing words based on how often they appear, it sizes them based on how similar they are to each other.

Semantic graphs show how topics are similar to network visualizations but focus more on showing how different pieces of information are related in meaning rather than just how they are connected[25] [26]. They are used to identify the main themes in a topic, summarize documents, and form the basic structure for databases that store knowledge.

We adopted a centroid-based approach similar to WCLOUDVIZ [17] to extract key sentences; however, unlike existing methods that relied on word-based similarity for sentence identification, we utilized sentence embedding and clustering. By utilizing sentence units rather than words as the core of news content, we were able to provide the semantic context.



Figure 3: Word Embedding applied to word clouds [24].

## 2.3. Time-based Changes in News Content

For visualizing changes in topics over time, there is ThemeRiver[27] (Refer to Figure 4). It visually represents the prominence of topics or groups in a large set of documents. ThemeRiver shows how these topics increase or decrease in importance over time, resembling the narrowing or widening of a river's flow. ThemeRiver's metaphors have inspired many visualization studies. The study [28] investigated the dynamics of the spread of memes and short phrases between the blogosphere and mainstream news media (Refer to Figure 5).

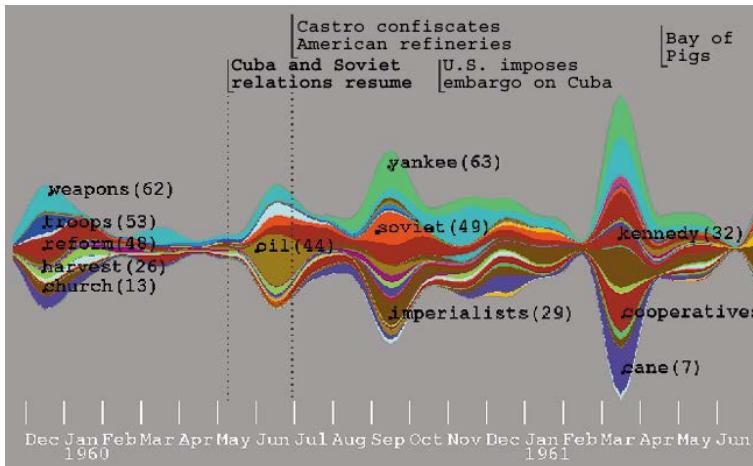


Figure 4: ThemeRiver. Using a river metaphor, this visualization shows the strength of topic keywords in documents over time, represented as varying widths [27].

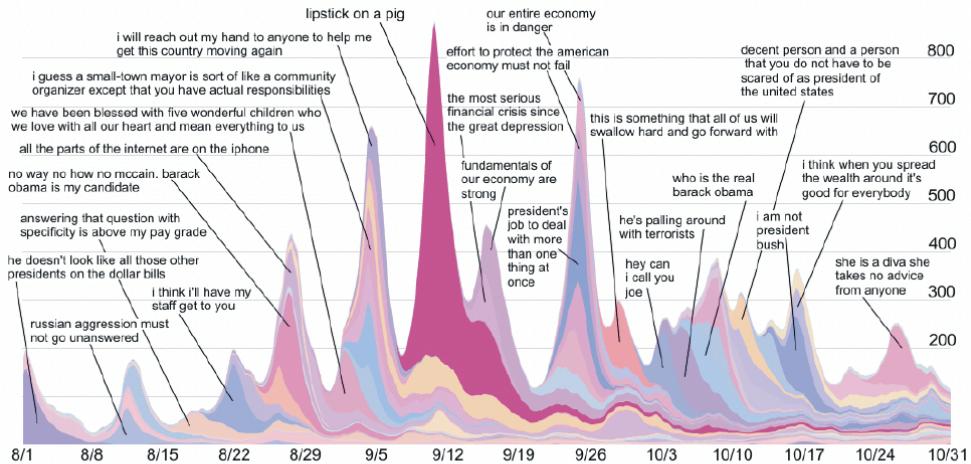


Figure 5: Visualization of meme-tracking, showing the data dynamics of memes and short phrases between mainstream news media and the blogosphere [28].

Studies on the evolution of news topics have led to the development of user-interactive news systems. These prior studies observe the distribution and change of news articles over time based on large categories [29] [30], or the distribution over time of news articles mentioning keywords such as major people or places[18] [31] [36]. However, research analyzing how the main content of news evolves from an event and issue perspective is rare.

The Event Registry API[29] and NDVS[30] observe the distribution and change of news articles over time based on broad categories and displays the distribution of news articles in different colors (Refer to Figures 6 and 7).

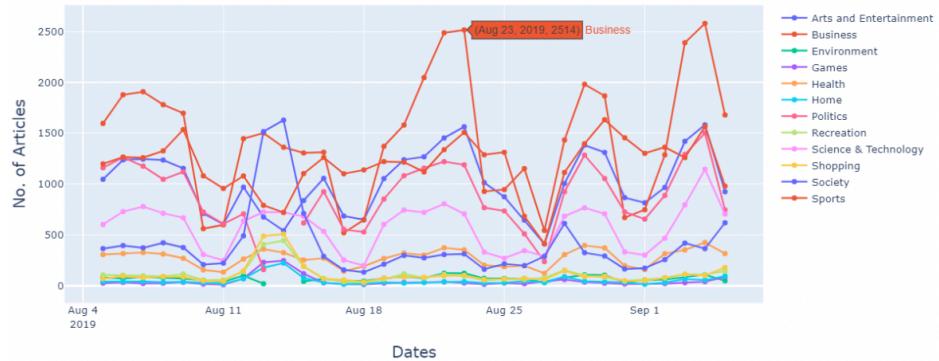


Figure 6: Event Registry API's time-series graph visualizes the sub-categories of news[29].



Figure 7: NDVS system displays the categories of news data in colors, showing their distribution over time [30].

NewsVAT[31] and Leadline[18] organize news stories by categorizing them into 5W1H(Why, What, Where, When, Who, How) and 4W(Who, What, When, and Where), respectively. Newdle[36] organizes news stories by keywords extracted from news articles. These systems display the keywords of news articles in word clouds and provide a time-series graph that visualizes the distribution of news articles related to the keywords selected by the user (Refer to Figures 8, 9, and 10). These prior studies only offer information based on keywords without any detailed explanation.



Figure 8: NewsVAT[31]. The word cloud is shown on the left, and the distribution of keywords is shown in a graph at the bottom right.

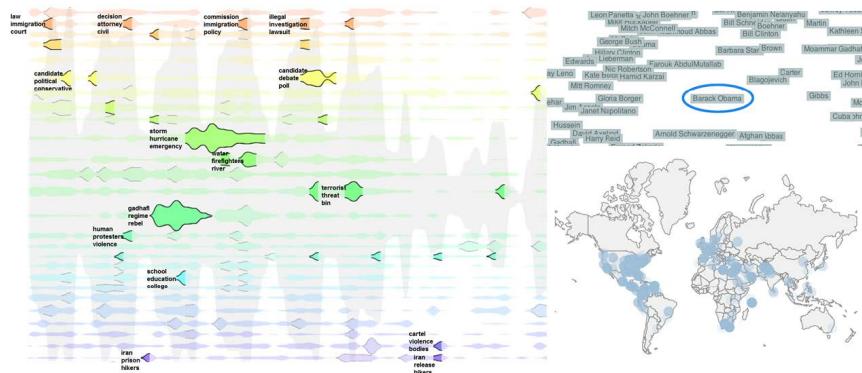


Figure 9: Leadline[18] maps and displays keywords related to the selected keyword 'What' over time.



Figure 10: Newdle[36]. The left side presents a word cloud of keywords extracted from news articles and a line graph visualizing the number of articles. The right side lists the news articles.

News organizations like BBC, The Economist, and edaily often create infographics or special sections on their websites for major issues they deem necessary. When such topics arise, they might arrange a timeline summarizing the issue's progression or dedicate a special section to the issue, presenting related news articles arranged over time[32][33][34][35]. This approach saves readers time exploring issue-related news and provides context to the issue's history, aiding in understanding. However, these services are usually curated or recreated by experts specializing in the respective issue, meaning they are unavailable for all news articles. In the absence of expert curation, such services are typically not offered.

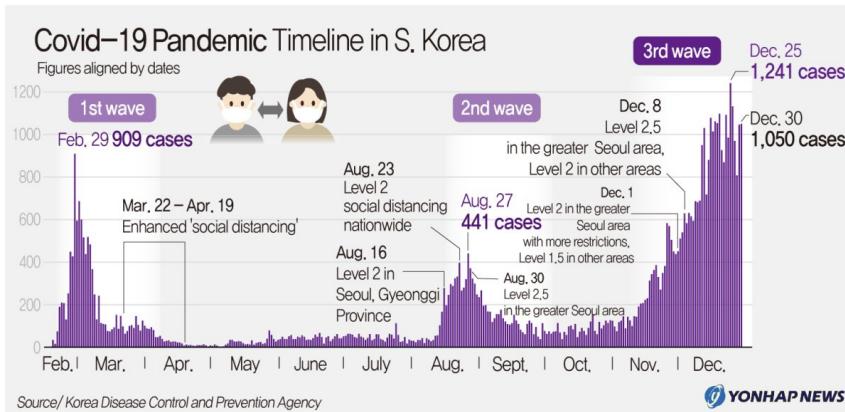


Figure 11: Infographic from Yonhap News, a Korean media company, showing the Covid-19 Pandemic Timeline

## **Chapter 3. Formative Study**

We conducted interviews with 12 adult participants to ascertain whether news readers in Korea actually encounter the inconveniences in digital news article consumption identified in prior research. From the interview, we discovered various problems users encounter while reading online news articles. These findings helped us select specific challenges to focus on, influencing the creation of Design Goals for our news system design.

### **3.1. Participants and Procedures**

Twelve adults(F01–F12) aged 19 and above who reported reading news articles at least once a week were recruited as participants through an online community. Of these participants, nine were female, and three were male. In terms of age distribution, nine participants (83.4% of the total) were in the age range of 19 to under 25 years, while one participant each (approximately 8.3% of the total) fell into the age range of 25 to under 30 years, and 30 to under 35 years.

The interview was conducted via an online meeting platform (Zoom). Before the interview began, participants completed a pre-interview survey providing demographic information (age, gender). The total duration of the interview varied between participants, ranging from 30 to 50 minutes.

### **3.2. Interview Methodology and Analysis**

In the interview, participants were engaged in a semi-structured interview focusing on their news consumption habits. The semi-structured format was chosen to balance comprehensive data collection with the flexibility for participants to share personal insights and experiences. The questions were designed to elicit detailed information about their experiences consuming online news articles

and any difficulties or discomforts they faced. The survey included the following open-ended questions:

**Q1:** What difficulties or inconveniences do you face when reading online news articles?

- Asking for descriptions of their experiences reading news online.
- Requesting explanations of any difficulties or discomforts encountered in the process.

**Q2:** What information do you seek in online news articles?

- Asking for explanations about the purpose of reading online news articles.
- Inquiring if the desired information is readily available in online news articles or if there are any discomforts in the information acquisition process.

The process of analyzing user interviews involved several key steps. The interviews were recorded and then transcribed into text using Naver CLOVA Note, with the data saved in CSV files for subsequent analysis. The transcribed data were then subjected to thematic coding. The process began with a line-by-line examination of the transcribed data. As we read through each line, we extracted meaningful statements from the participants and organized these statements into significant units. This phase was crucial for identifying recurring patterns and themes within the participants' responses. We began with predefined codes directly related to our research questions, such as 'difficulty in reading online articles' and 'purpose of reading news.' As we delved deeper into the data, new themes emerged, leading us to develop additional codes like 'brevity of news articles' and 'articles with clickbait titles.' These initial codes were then grouped into broader themes. Examples of these broader themes include 'the inconvenience of exploring multiple news sources' and 'demand for comprehensive articles.' This categorization process was essential for organizing the data into coherent and meaningful groups.

Our coding process was iterative. Following the initial coding, we repeatedly revisited the data. Each review allowed us to refine and reclassify the themes, enhancing our understanding of the data.

The final step of this process was combining these themes into a clear and connected story, understanding how different themes interconnected and impacted a news system's basic requirements and challenges.

### **3.3. Findings and Discussions**

Participants shared their experiences regarding the platforms and methods they use for reading news articles based on the interview questions. The analysis of these interviews led to identifying two basic requirements and five challenges essential for designing an effective news system.

#### **3.3.1. Basic Requirements**

##### **Basic Requirements1: Design for News Aggregator.**

Regarding the frequency of reading news articles, seven participants reported reading news articles 3–4 times a week, four participants 5–7 times, and one participant 1–2 times. The majority, 11 participants, reported using Naver News, utilizing both the app and webpage. One participant primarily used Google News to access news articles from the main page of the mobile Google app. Participants tended to use news aggregators more than visiting individual news websites, which is consistent with the findings of [1][3].

##### **Basic Requirements2: Design for Webpage News Services.**

Most interview participants tended to read the news mainly in the morning to get updates on ongoing issues and as a time-filler between other schedules. None of them reported using news-related notifications to read news, supporting the findings of the study [13] that people generally do not prefer news alerts. Therefore, any news system and its interface should make alert features optional, not pushing the user but easily accessible whenever the user wishes, mainly catering to those who read the news as a time-filler.

Consequently, a news system that is readily accessible on both PC and mobile, without restrictions, in the form of a webpage, is advisable.

### 3.3.2. Identified Challenges

The following are the primary themes identified as Challenges from the interviews.

#### Challenges1: Inconvenience of Reading Multiple News Articles.

Participants in the study reported feeling overwhelmed by reading multiple news stories about a particular event for various reasons:

First, the study found that many news stories have sensationalized headlines that do not match the depth or relevance of the content. This inconsistency led participants to read multiple stories, and they found significant overlap in content across sources. Participant F09 pointed out that *“Nowadays, there is a lot of competition between media companies, so the headlines are often sensationalized and shocking, but there is not much content in the text.” “When you click on an article, it is often the same as another article or just one line.”*

Also, participants felt that reading just one news article often left them with a sense of missing out on information, prompting them to read several articles. However, this usually results in encountering repetitive information, indicating redundancy in news content. Participant F11 responded, *“Sometimes I feel like I'm not getting the information I want because the headlines are sensationalized and there's no content, or the breaking news is all headlines and no content.”*

In Addition, there was a concern about potential bias in news reporting. Participant F07 felt compelled to read articles from various news outlets on the same issue to obtain a more balanced view, highlighting the inconvenience of accessing multiple sources to avoid biased perspectives.

F07: *“If the headline seems biased or the article's intent seems to be something other than conveying facts, I'll look for other news sources to get more information.”*

## **Challenges2: Difficulty in Navigating News Articles.**

Participants primarily used issue-related keywords when searching for additional information on news topics. However, they expressed frustration with the design of the search results interface, which is more suited to searching for general information rather than browsing news articles. Results are often displayed in a list or dashboard format, which can be overwhelming and not conducive to quickly sifting through a vast amount of articles. Participants also noted that even when news articles are sorted by "latest," they often display excessive breaking news and short news snippets, making in-depth exploration difficult. Sorting by "relevance" was also problematic, as it often did not indicate the temporal progression of events.

*F09: "When I heard the news about the diesel exhaust (DEF) shortage, I was curious about what was going on, so I looked up Naver News for more information."*

*"When I searched for the keyword in Naver News, there were too many breaking news and one-line news in the latest order, and when I sorted by relevance, I couldn't find the exact time flow. So, I looked for posts organized by people on other SNS or communities."*

## **Challenges3: Difficulty in Deciding Which News Articles to Read.**

Some news readers have trouble deciding which articles to read: three of our interviewees(F01, F08, and F10) said they had trouble choosing articles. Most participants rely on the order of articles on search platforms to click on the top results, which raises questions about the quality and relevance of top-ranked articles on news aggregators or portal sites. "Newest" search results may prioritize the most recent articles, but this may unintentionally exacerbate the problem of news article saturation by increasing the visibility of frequently published outlets [8] [10] [11] [12]. Five participants (F02, F05, F07, F09, and F11) also acknowledged that when viewing a list of news articles, they tend to click on the most sensational or interesting-looking titles.

**F08:** “When I search for a news story to learn more about an issue, I look at the search results and think for a moment about which news story to read. I usually read the one at the top.”

#### **Challenges4: Limited Availability of Comprehensive Articles.**

Some participants indicated that they first look for "Comprehensive articles(종합 기사)" when encountering news about complex events." Comprehensive articles differ from "feature articles," which contain in-depth stories and journalist opinions. While less detailed than feature articles, comprehensive articles offer more coverage than standard news. Readers preferred these comprehensive articles over straightforward articles that relay a single fact, as they found it easier to grasp the main content of the issue. However, not all news topics were addressed in comprehensive articles. Additionally, such comprehensive articles might not contain the most current information, owing to the date of publication.

**F01:** “When I search for news, I prefer to read news that is organized in an aggregate or timeline fashion. However, not all articles are organized in this way. If the article is old, it may not reflect the latest information.”

#### **Challenges5: Difficulty in Understanding the Progression of Issues.**

Readers had trouble understanding the context of news that wasn't in their area of interest or expertise. Some interviewees sought out blog posts or YouTube content with clear explanations to get additional clarification. One participant (F04) mentioned reading a news article about a South Korean politician's hunger strike a few months ago. Curiosity led him to search for more information, but the complexity and length of the article required to understand the issue made it difficult to get the full context, and he gave up.

**F04:** “Regarding Lee Jae-myung's hunger strike, the latest articles I've come across simply state how many days he's been on the strike. It's

*frustrating that I often lack detailed insight into the problem and have to search for more information.”*

**Researcher:** “*Could you tell me how you looked for more information?”*

**F04:** “*I googled 'Lee Jae-myung hunger strike,' and there was some material about prosecutors and legal issues, but the information was jumbled and hard to understand, so I eventually gave up trying to make sense of it.”*

### 3.4. Design Goals and Requirements

Based on findings from the formative study, we have established two design goals for our news system. Each goal was accompanied by specific requirements tailored to address the challenges identified in the interview.

#### DG1: Integrating Key Content from Multiple News Sources

The first design goal (DG1) addresses challenges C1, C3, and C4. This goal focuses on extracting and presenting key content from multiple news articles covering the same event. The aim is to alleviate reader fatigue caused by sifting through numerous articles with overlapping content (C1). It also aims to simplify identifying news articles that align with the reader's interests in the issue and reduces indecision regarding which articles to read (C3). By analyzing and summarizing the key points from a collection of news articles related to an event, our system offers a comprehensive perspective similar to a singular, in-depth news article. This approach is a strategic solution to overcome the limitations of fragmented news coverage (C4).

##### ***Requirements 1. Extract key content and present subtopics:***

This requirement focuses on extracting and displaying primary content from various news articles through clearly defined subtopics. The objective is to present these subtopics at the forefront before engaging with the full articles. This approach serves a dual purpose: First, it furnishes users with essential preliminary information,

facilitating a foundational understanding of the news content. Second, it aids users in making an informed decision about whether to delve deeper into the full articles.

***Requirements2. Provide detailed information in subtopics:***

This requirement entails providing additional, concise information in brief sentences accompanying the subtopics. The aim is to furnish users with deeper insights into the subtopics. It addresses news content's challenges for clarity, information depth, and time efficiency.

## DG2: Outlining the Temporal Evolution of Issues

The second design goal (DG2) is developed to meet challenges C2, C3, C4, and C5. With a deluge of news articles published daily, tracking the evolution of news issues over time is a daunting task (C5). Finding articles to understand past events is challenging (C2) and often requires laborious efforts to sift through historical content or conduct keyword searches (C3). An expert summarization of related content would be ideal but is not always feasible (C4). Therefore, DG2 aims to provide a structured overview of the temporal evolution of significant news issues, benefiting readers who may not follow news regularly. This approach facilitates an efficient understanding of the progression and development of issues over time.

***Requirements3. Visualize Temporal Evolution:***

This requirement aims to enable users to easily comprehend news issues' chronological development. By graphically depicting how stories evolve, this visualization assists users in understanding the temporal dynamics of news narratives, thereby enhancing their grasp of the unfolding of events and the context in which they occur.

***Requirements4. Make Past Events Easily Accessible:***

This requirement emphasizes providing a navigable list or similar format that allows users to easily access important articles about past events. This is useful for users following a news issue as it develops.

# Chapter 4. News Snapshot

To achieve our design goals, we designed and developed News Snapshot, a novel news system which delivers the key points of a news articles and the outline of an issue's progression.

## 4.1. Overview

The News Snapshot was conceptualized as a web-based News aggregator service, in line with the Basic requirements (B1, B2) identified in the Formative Study. Figure 12 illustrates the overall structure of the interface.

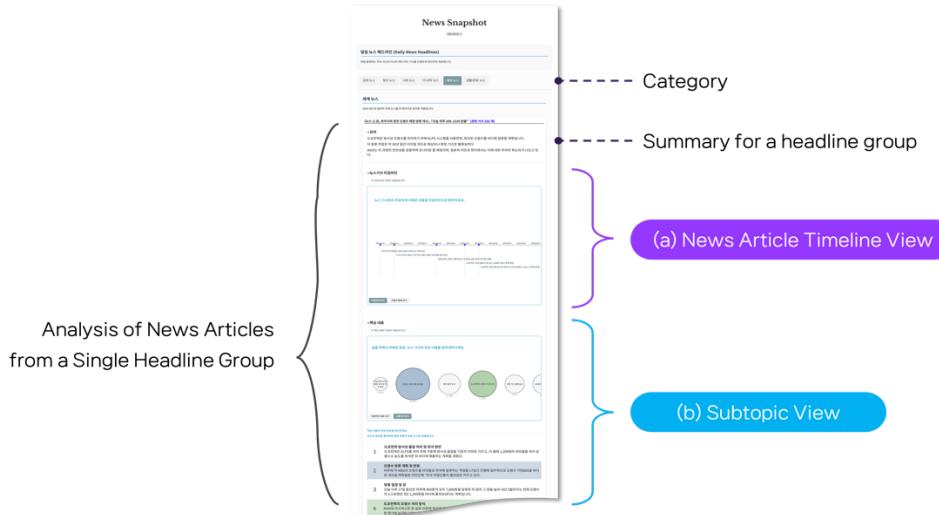


Figure 12: An overview of 'News Snapshot' interface. There is a tab at the top for selecting categories, and at the bottom, news items are listed in order. Each news item presents a summary along with a News Article Timeline View and a Subtopic View.

The basic structure of News Snapshot is depicted in Figure 13. The interface includes a menu at the top for selecting categories, each presenting a single day's news articles. The source of the news articles is the headlines from the Naver News service. Consequently, up to 10 headlines per category are provided daily, each representing a collection of news articles on the same event. For each headline

group, News Snapshot displays a News Article Timeline View and a Subtopic View.

The Subtopic View is always available for each headline, whereas the News Article Timeline View is only offered when the article is related to an issue that evolves over time.

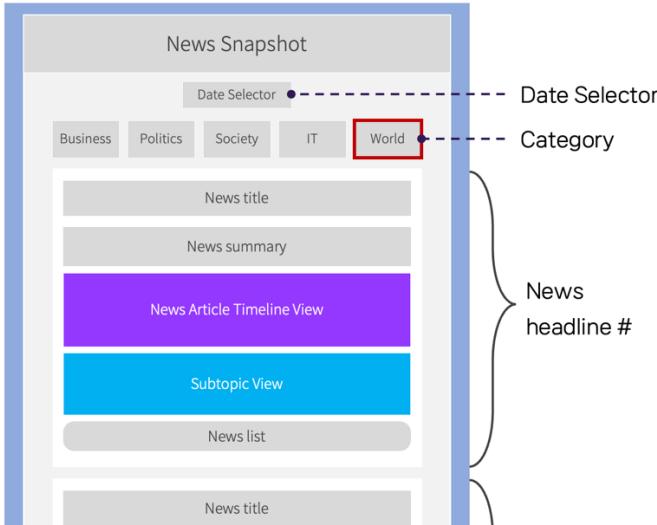


Figure 13: Basic structure of News Snapshot. At the top, there's a Date Selector and Categories, followed by News headlines listed in order.

To structure the news data within the Subtopic View and the News Article Timeline View, we devised a strategy for clustering sentences from news articles. We collected sentences from news articles and performed a clustering task. As a result, clusters of similar sentences were obtained. The content discussed within each cluster can be seen as the main content that is frequently mentioned in news articles. This method extracts subtopics from news articles covering the same event. Furthermore, clustering news data over several dates and arranging the clusters in chronological order can reveal the temporal evolution of the issue.

This system comprises a server program for processing news data and a web interface for user interaction (Refer to Figure 14).

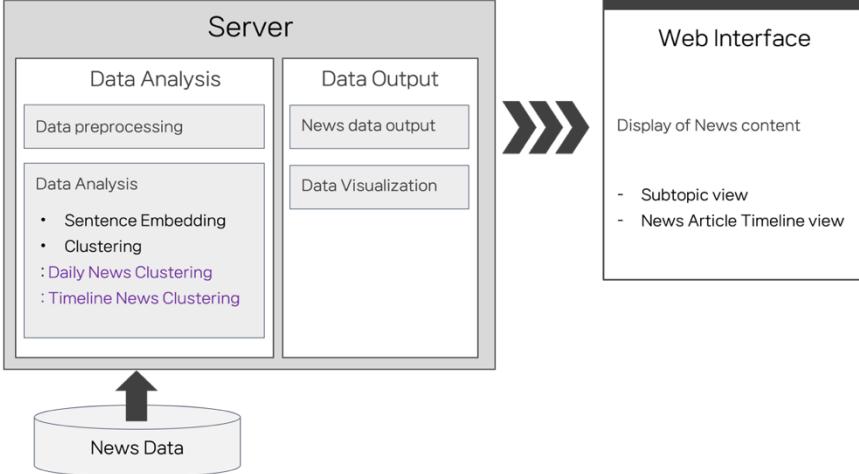


Figure 14: System architecture of a News Snapshot. It consists of a Backend Server and a Front-end Web Interface.



Figure 15: The 'Politics' news category screen on Naver News. Up to 10 'Headlines' are displayed for each category. Each Headline lists news articles from various media outlets covering the same event.

## 4.2. News Data Collecting and Preprocessing

Existing Korean news datasets were not suitable for our research purposes. The required dataset for our study contained a large volume

of news articles on the same event, prompting the decision to build our dataset. Therefore, we constructed our own dataset for the research.

The Formative Study revealed Naver News as the participants' most frequently used service platform for consuming news. As such, we collected news articles from Naver News from July 4, 2023, to October 20, 2023. Naver News categorizes articles into politics, economy, society, and many other categories. Each category features up to 10 headline topics daily (Refer to Figure 15). Each headline topic is associated with a collection of news articles, ranging from at least 10 to hundreds. These headline articles were collected for the dataset.

The collected news dataset was divided by category and stored in separate files. The dataset file names are structured in the following pattern: they start with a date and time, followed by an underscore, and end with a news category.

For example, "*NewsGroup\_2023092212\_Business.csv*" consists of a timestamp (2023092212) representing the date and time and "Business" at the end representing the news category. The dataset of news articles collected from July 4, 2023, to October 20, 2023, comprises a total of 524 files. From July 4 to August 12, only articles in the "Politics," "Business," and "Society" news categories were collected. Later, the "Technology" and "World" categories were added to the collection. The "Life" news category began to be collected on August 16. Initially, we focused on analyzing news in the three main categories. However, as big issues such as 'Fukushima contaminated water discharge,' 'The Russia–Ukraine war,' and 'The Hawaii wildfires' arose, we needed to expand the scope of news articles. Therefore, we made a strategic decision to collect articles from all news categories from August 16 to prepare for potential issues that may arise in the future.

The total number of rows in the dataset is 13,001, containing 1,3001 news articles. The columns included {index, link, title, date, group\_index, article}. 'date' refers to the publication date specified in

the news article, and 'group\_index' indicates the sequence of the headline topic within the news category.

During the text preprocessing phase, HTML tag styles, scripts, whitespace, tabs, and other special characters were removed, along with unique proper nouns and text patterns specific to news articles. Table 1 provides examples of text patterns removed from the news articles.

Table 1. Some examples of regular expression patterns used for removing unnecessary sentences in news articles.

Regular Expression Pattern	Reason for Removal
[WS]* 기자입니다	Journalist/News Reporter Name
[가-힣]{2,4} 기자 [a-zA-Z0-9_.+-]+	Journalist/News Reporter Name
사진Ws*=Ws*인스타그램Ws*'[Ww_]*'	Image Source/Credit
[^a-zA-Z0-9 가-힣]*게티이미지뱅크	Image Source/Credit
당신의 제보가 뉴스[가-힣Ws]*	News Tip Submission Request

### 4.3. News Data Embedding and Clustering

The preprocessed news data underwent sentence embedding and clustering. The sentence embedding served two purposes: firstly, to filter out sentences irrelevant to the news article that were not removed during preprocessing, and secondly, to produce data for clustering that precisely encapsulated the semantic essence of the sentence data.

There are two types of clustering processes: Daily News Clustering and Timeline News Clustering. Each type of clustering has a distinct role within the system: Daily News Clustering is designed to produce data for the Subtopic View, while Timeline News Clustering is aimed at generating data for the News Article Timeline View (Refer to Figure 17).

### 4.3.1. Sentence Embedding

The collected news articles were segmented using Kiwipiepy [40], a Python module of the Korean morpheme analyzer Kiwi. Testing revealed that among Korean sentence segmentation tools, Kiwi stood out for its speed and accuracy in parsing based on morphological analysis, leading to its selection for this task.

The separated sentences were then embedded using the Sentence-BERT model pre-trained on the KLUE NLI dataset ('snunlp/KR-SBERT-V40K-klueNLI-augSTS') [41].

### 4.3.2. Filtering Out Unnecessary Sentences

After embedding, we filtered out unwanted content based on sentence similarity. This step allowed us to exclude sentences that were not removed in the preprocessing step. We used cosine similarity to compare sentences. Two thresholds were used for comparing sentence similarity: 0.09 for the last sentence and 0.05 for all other sentences.

The last sentence of an article was often considered unimportant, such as a call to action or closing remark. So, we applied a high threshold of 0.09 to the last sentence to retain only sentences that were significantly similar to the previous sentence. On the other hand, sentences in the body of the article typically contained little unnecessary information. These sentences, which typically introduced a new situation or step, had similarity scores to previous content as low as 0.05. We set the threshold as low as 0.05 to minimize the accidental deletion of these informative sentences.

As the algorithm progressed, the sentences in each news article were examined in sequence. A cosine similarity was calculated for each sentence in the sequence to determine whether to keep the sentence or remove it. The way a sentence was treated depended on its position in the sequence. For sentences that were not the last sentence, the algorithm checked for both similarity to the previous sentence and similarity to the following sentence. Consider a scenario where the similarity between the previous sentence and the current

sentence was below the threshold. However, the similarity between the previous sentence and the following sentence was above the threshold. In this case, the current sentence was considered invalid and was removed. When evaluating the last sentence in the sequence, the algorithm used a different strategy: it compared the similarity of the previous sentence to the sentence before it. The algorithm removed the last sentence if both comparisons resulted in a similarity score below a threshold. This technique effectively removed unnecessary sentences from news articles.

#### 4.3.3. Tokenized-sentence embedding and keyword extraction

A tokenization process was followed, and sentences were re-embedded in a token-merged format. KeyBERT [42] was then used to extract keywords from each news article. These keywords were instrumental in determining whether articles addressed the same issue. The resulting data was structured as {group\_index, article\_index, link, title, date, sentence\_index, sentence, tokens, keywords}.

The diagram illustrates the transformation of a raw dataset sample into a processed dataset sample. The raw sample (top) contains a single row of data with various fields like index, link, title, date, group\_index, and article. The processed sample (bottom) shows the same data split into multiple rows, where each row corresponds to a sentence within an article. The 'article' field from the raw sample is broken down into 'tokens' and 'keywords' in the processed sample, with arrows indicating the mapping between them.

index	link	title	date	group_index	article
0	https://n.news.naver.com/mnews/article/052/000...	국민의힘 조강특위, 오신환 광진을 내정...마포갑 보류	2023.08.25	0	국민의힘 조강특위가 오신환 전 의원을 서울 광진을 조직위원장에 내정하는 등...
1	https://n.news.naver.com/mnews/article/119/000...	국 조강특위, 29일 회의서 강서을 김성태 등 5-6곳 추가 인선	2023.08.25	0	29일 추가 인선 후 31일 최고위서 의결강서를 김성태 등 5-6곳 추가될 듯오신환...
2	https://n.news.naver.com/mnews/article/003/001...	[단독]여당 조강특위, 29일 강서을 등 5-6곳 '최종 결정'	2023.08.25	0	29일 한차례 조강특위 회의 후 31일 최고위 의결 서울=뉴시스 전진환 기자...

article_index	link	title	date	group_index	sentence_index	sentence	tokens	keywords
0	https://n.news.naver.com/mnews/article/052/000...	국민의힘 조강특위, 오신환 광진을 내정...마포갑 보류	2023.08.25	0	0	국민의힘 조강특위가 오신환 전 의원을 서울 광진을 조직위원장에 내정하는 등...	['국민', '힘', '조강특위', '서울', '광진', '조직', '특위', '오신환', '전', '원', '원회', '추가', '인선', '한차례', '최종', '결정']	['조강특위', '서울', '광진', '조직', '특위', '오신환', '전', '원회', '추가', '인선', '한차례', '최종', '결정']
1	https://n.news.naver.com/mnews/article/052/000...	국민의힘 조강특위, 오신환 광진을 내정...마포갑 보류	2023.08.25	0	1	윤석열 대통령의 서울 대 법대 후배이자 연수원 동기인 고석 변호사는 경기 용인방 조직...	['윤석열', '대', '법대', '후배', '연수원', '동기', '고석', '변호사', '경기', '용인방', '조직']	['조강특위', '서울', '광진', '조직', '특위', '오신환', '전', '원회', '추가', '인선', '한차례', '최종', '결정']
2	https://n.news.naver.com/mnews/article/052/000...	국민의힘 조강특위, 오신환 광진을 내정...마포갑 보류	2023.08.25	0	2	조, 당내 유일한 호남 지역 의원인 재선의 이용호 의원과 비례대표 최승재 의원이 ...	['조', '당내', '유일', '한', '호남', '지역', '의원', '재선', '이용호', '최승재']	['조강특위', '서울', '광진', '조직', '특위', '오신환', '전', '원회', '추가', '인선', '한차례', '최종', '결정']

Figure 16: Above, dataset sample (raw); below, dataset sample (processed). Articles are split into sentences and stored as individual rows.

#### 4.3.4. Daily News Clustering for Subtopic View

We clustered encoded sentences to discern the subtopics discussed in numerous news articles about a particular event published on a given day. This approach helped to identify and extract the main content commonly addressed in the news group for that specific event. As a result of the clustering, we obtained clusters grouped by similar subtopic sentences, providing a clearer picture of the key points of events on a particular day (Refer to Figure 18).

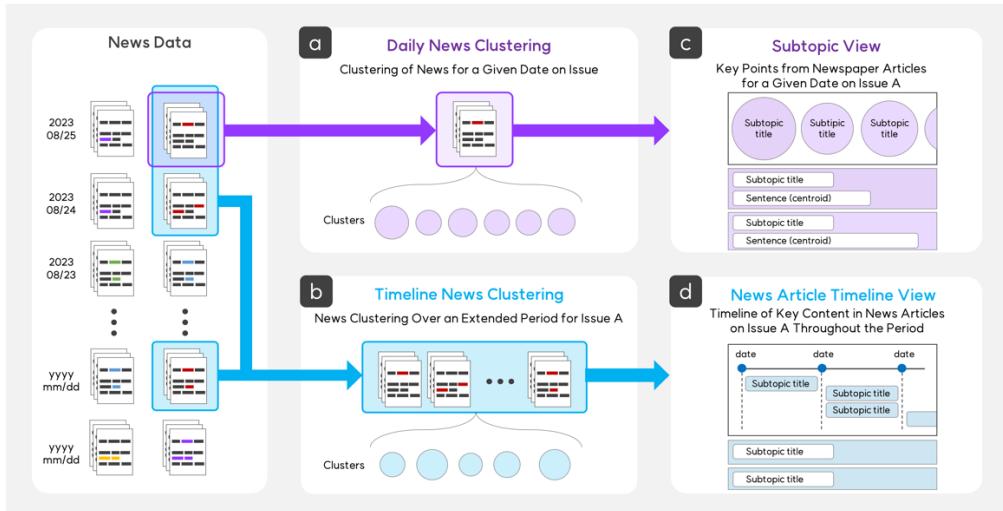


Figure 17. Clustering is of two types: Daily News and Timeline News, each forming Subtopic View and Timeline View in the interface, respectively.

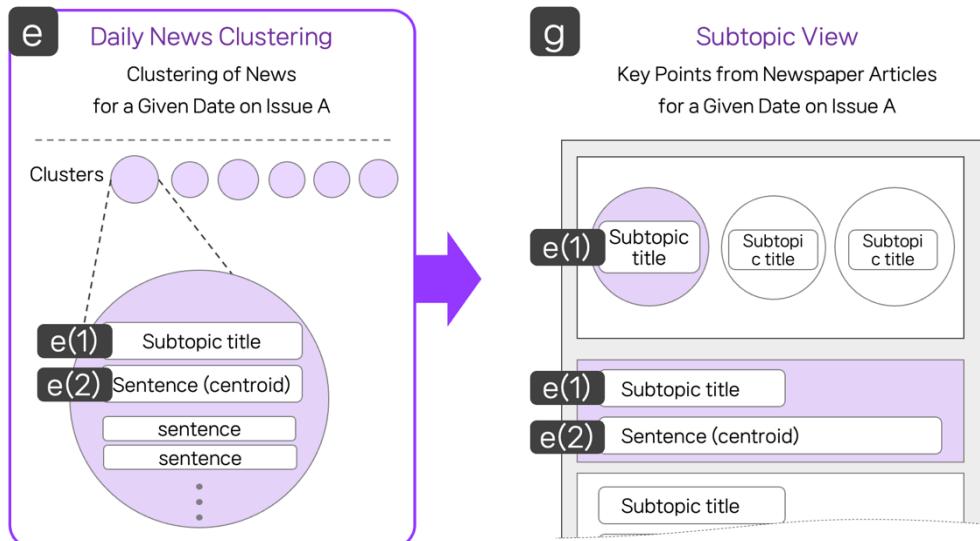


Figure 18: The data from Daily News Clustering forms the Subtopic View in the final interface.

The methodology for clustering the news articles used Meta's Faiss API [43]. The clustering method used the K-means clustering supported by Faiss. The optimal number of clusters (K) was automatically determined using the elbow method.

The centroid sentence of each cluster was considered representative of that cluster; however, if the center sentence was too short or too long (less than 10 characters or more than 150 characters in Korean characters), an alternative centroid candidate was selected.

Each centroid sentence was converted to a title format that included keywords and used as the title for each cluster. We used OpenAI's GPT-3.5-Turbo model to generate keyword-based titles that implied the meaning of the sentence. The generated titles and centroid sentences were utilized in the subtopic view.

In addition, summaries for each newsgroup were generated by inputting the centroid sentences of each group cluster into the GPT-3.5-Turbo model to condense the information into 3–5 sentences.

#### 4.3.5. Timeline News Clustering for News Article Timeline View

To analyze the temporal distribution of news articles related to a specific issue, we clustered sentences from various time periods that pertained to the same issue, as depicted in Figure 19. The process of identifying news articles about the same issue involved several steps:

Firstly, a semantic search was conducted using the title of a target news article. In our study, the semantic search was implemented as follows: We utilized the Faiss API's IndexIDMap to load pre-embedded news sentence data, serving as a vector database. This database enabled the measurement of vector similarity for search queries and the derivation of search results.

From the resulting sentences, we compiled a list of associated news articles, ensuring no duplicates. Subsequently, we examined the keywords in these articles. Only articles sharing at least one keyword with the target news article were selected for clustering. This keyword comparison was crucial due to the limitations of semantic sentence search. While semantic search is effective at identifying highly similar sentences, the actual news articles that contain these

sentences may have been briefly mentioned in the context of other events unrelated to the searched sentence, so it is necessary to ensure that the actual news article covers the same topic as the targeted news article as a whole.

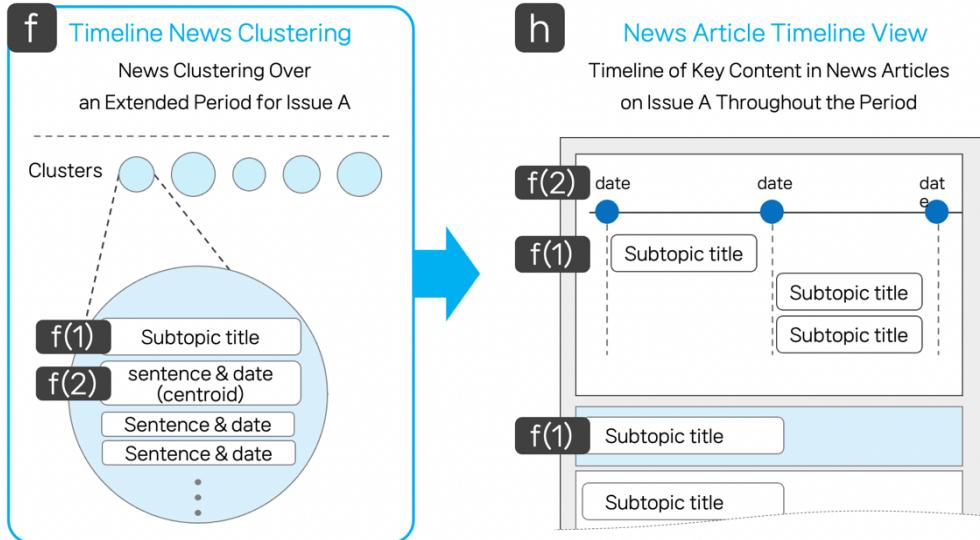


Figure 19: The data from Timeline News Clustering forms the News Article Timeline View in the final interface.

Similar to the Daily News Clustering task, we consider the sentence corresponding to the centroid of each cluster as the representative sentence in Timeline News Clustering. However, if the center sentence was too short or too long (less than 10 characters or more than 150 characters in Korean characters), an alternative centroid candidate was selected.

Each centroid sentence underwent a conversion into a title format, incorporating relevant keywords, and was subsequently employed as the title for its respective cluster. We utilized the OpenAI GPT-3.5-Turbo model for generating titles based on keywords, ensuring that these titles conveyed the essence of the sentences. The titles thus generated were then integrated into the News Article Timeline View.

## 4.4. Interface: Subtopic View

### 4.4.1. Purpose and Key Features

To satisfy design goal DG1(Integrating Key Content from Multiple News Sources), an interface displaying the key contents of news article groups covering the same event was designed. These key contents are provided for each news group daily.

Each cluster obtained by Daily News Clustering represents a subtopic of news headlines covering the same issue in today's news articles. These clusters are visualized in the "Subtopic View" of the News Snapshot interface. As shown in the sample screen of the key content in Figures 20 and 21, clusters are visualized alongside a list providing detailed information.

Sentence clusters within a group of articles are represented as circles arranged in a sequence. The size of each circle corresponds to the proportion of sentences it contains relative to the total number of sentences in all clusters. Subtopic keywords, identified as the key content, are displayed within each circle, providing a quick overview of the thematic focus of each cluster. Below this visual representation, a detailed list is provided. This list elaborates on the subtopics by displaying representative sentences associated with each keyword. This format offers a more nuanced understanding of the content. Additionally, the list items are interactive; clicking on them links to the source of the representative sentences, allowing users to access and read the full news articles for more comprehensive information.

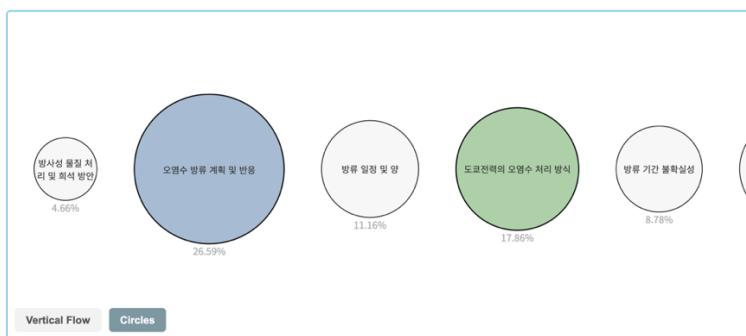


Figure 20: [Subtopic View] Circles. Key contents are each represented by a circle. The size of each circle corresponds to the importance of its content



Figure 21: [Subtopic View] Vertical Flow. Key contents are each represented by a horizontal bar and arranged vertically

#### 4.4.2. Two Screen Design Concepts

Two distinct concepts for the Subtopic View were conceived, each with clear advantages and disadvantages. In this study, a definitive choice between the two concepts was not made; instead, users can select which of the two screens they prefer to view.

**Circles:** Key contents are each represented by a circle. Each circle's size corresponds to its content's importance, i.e., the number of sentences in each cluster. Circles are aligned horizontally in a Left-to-Right (LTR) direction. This alignment is based on the convention of reading from left to right. However, for cultures or countries that read Right-to-Left (RTL), an adjustment to align right to left can be made. (While the RTL concept was planned, it was not implemented in the research prototype for user evaluation, which was based on the LTR-reading Korean context.)

**Vertical Flow:** Key contents are each represented by a horizontal bar and arranged vertically. The design is particularly convenient for browsing environments with narrow horizontal space and familiar

vertical scrolling, such as on mobile devices. Considering that people generally read from top to bottom, this design aims to provide a similar experience. To create a continuous experience with the News Article Timeline View in Feature 23, a blue circle is placed at the top to represent the content of the given date in the issue's timeline.

#### 4.4.3. Key Sentences List

Below the Subtopic View is a list with the title of each subtopic cluster and its representative sentence (centroid sentence), arranged in order. Clicking on an item in the list links to the original news article that the representative sentence came from. The list is designed to emulate the experience of reading a single news article, providing a familiar and coherent reading experience.

- 1 방사성 물질 처리 및 회석 방안**  
도쿄전력은 ALPS를 여러 차례 가동해 방사성 물질을 기준치 이하로 거르고, 이 물에 1,200배의 바닷물을 섞어 삼중수소 농도를 회석한 뒤 바다에 배출하는 계획을 세웠다.
- 2 오염수 방류 계획 및 반응**  
하루에 약 460t의 오염수를 바닷물로 회석해 방류하는 작업을 17일간 진행해 일차적으로 오염수 7천800t를 바다로 내보낼 계획일본 어민단체 "전국 어업인들의 불안감은 커지고 있다."
- 3 방류 일정 및 양**  
오늘 이후 17일 동안은 하루에 460톤씩 모두 7,800톤을 방류한 뒤 점차 그 양을 늘려 내년 3월까지는 전체 오염수의 2.3 분량인 3만 1,200톤을 바다에 흘려보낸다는 계획입니다.
- 4 도쿄전력의 오염수 처리 방식**  
NHK와 아사히신문 등 일본 언론에 따르면 도쿄전력은 다핵종제거설비ALPS를 거쳐 후쿠시마 제1원전 부지 내 저장 탱크에 보관된 오염수를 이날 오후 1시 3분부터 바닷물로 회석한 후 방류했다.
- 5 방류 기간 불확실성**  
오염수 방류는 30년 가량 이어질 것으로 예상되지만, 정확한 방류 기간은 확정지울 수 없는 상황이다.
- 6 IAEA의 참여와 검증**  
라파엘 그로시 IAEA 사무총장은 "IAEA가 현지에 머무르며 계속 검증할 것"이라고 말한 바 있다.
- 7 어민 및 현지 반응**  
NHK는 방류개시 발표 직후 "손님보다 이끄랑이 줄까봐 걱정이다. 어민들이 오염수 논란 때문에 이로 작업에 나서지 않을 것"이라는 현지 해산을 식당 주인의 우려를 전하며 "정부와 도쿄전력이 더 적극적으로 나서야 한다는 목소리가 나온다"고 했다.
- 8 방류의 배경**  
오염수 방류는 2021년 4월 스가 요시히데 당시 총리가 오염수의 해양 방류를 결정한 지 2년 4개월 만이며, 2011년 3월 11일 동일본대지 진으로 후쿠시마 원전 사고가 발생한 지 약 12년 만이다.

Figure 22: [Subtopic View] Key Sentences List. Below the Subtopic View, a list displays each subtopic cluster's title and key sentence, arranged sequentially, with each item linking to the original news article upon clicking.

#### 4.4.4. Subtopic Sequence and Color Coding

This feature facilitates quick and easy identification of the main content within a group of news articles. We initially considered organizing core content based on cluster size, where larger sizes mean higher frequencies of related sentences within the overall article. However, this approach could disrupt some articles' chronological and logical order, resulting in confusion. For example, readers might learn about the effects or details of a 'subject' without first understanding what the 'subject' actually is. Our goal was for readers to experience reading a condensed news article when perusing the Key Sentence List, which combines the core content and representative sentences.

We chose an indirect method over more sophisticated NLP tasks, such as extracting causal relationships or chronological order to maintain the textual context in which each content is mentioned within the news articles. Each sentence in a news article was assigned a serial number based on its position, and this position value was recorded. We then calculated the average position value of sentences within each cluster and presented this content in ascending order of these values. After testing this method with over 50 news articles, we found that while the length of most articles did not significantly impact the effectiveness of this sorting method, in some cases, it correctly placed content that should be introduced first at the beginning, similar to reading a news article.

Additionally, color coding was used for the top three core content items with the highest proportion to achieve the original goal of quickly conveying the main content of a group of news articles. Using the Tableau 10 palette [44] for category differentiation, we decided not to assign semantic significance to colors. This decision was based on our observation that the most frequently mentioned sentences in news articles do not always contain the essential content and that the importance of content can vary depending on readers' values and background knowledge.

## 4.5. Interface: News Article Timeline View

### 4.5.1. Purpose and Key Features

The News Article Timeline View, aligning with Design Goal DG2 ('Outlining of the Temporal Evolution of Issues'), illustrates the progression of news stories over time. This feature enhances the user experience by enabling readers to easily track and understand the evolution of an issue without the need to sift through previous articles manually.

Clusters obtained through Timeline News Clustering represent subtopics on the same issue across multiple dates in news articles over the entire period. Each cluster contains articles about a specific subtopic of a larger issue from different dates—this can show how different aspects of an issue have been covered in the news over time.

The centroid news sentence for each cluster is considered the representative news sentence. We consider the date that the original news story for this news sentence was published to be the representative date for each cluster. Then, we sort the clusters chronologically according to the representative date. This timeline view makes it easy to track how the discussion and coverage of different aspects of an issue have changed and evolved over time.

Figures 23 and 24 show the two concepts of a News Article Timeline: "Simple Timeline" and "Dynamic Timeline." The 'Simple Timeline' provides a more straightforward, linear display of events. In contrast, the 'Dynamic Timeline' can provide an interactive timeline, allowing more detailed exploration of news content over time.

### 4.5.2. Two Screen Design Concepts

The default option, "Simple Timeline," displays the main content of a news article as a short phrase under each date. "Dynamic Timeline" shows the distribution of the main content by visualizing clusters of sentences across multiple dates as an area chart. In this configuration, special care has been taken to ensure that the same news article is not included in a cluster more than once. In addition, links to representative news articles corresponding to each section of

the graph are provided in the area below the graph, providing direct access to more detailed information.

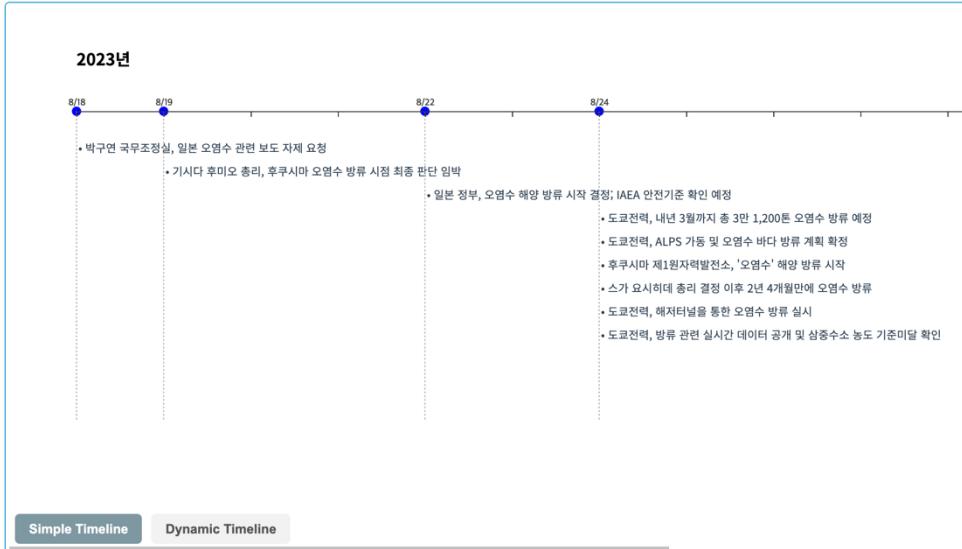


Figure 23: [News Article Timeline View] Simple Timeline. It simply shows the main contents of issues over time in a horizontal timeline.

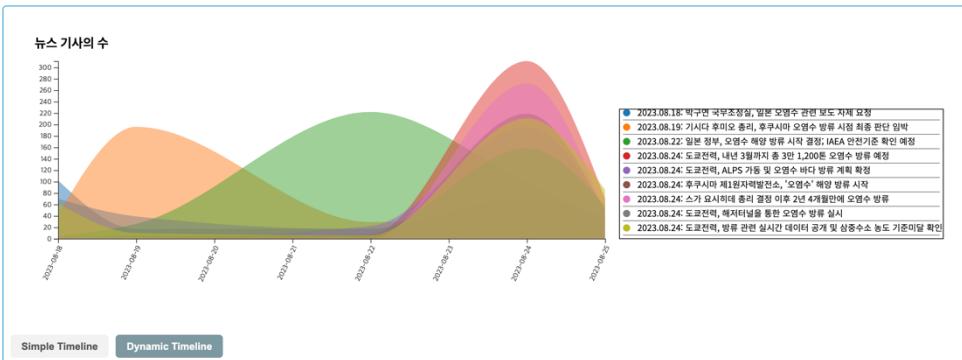


Figure 24: [News Article Timeline View] Dynamic Timeline. A Stacked area graph shows issue trends over time, with the y-axis indicating the count of news articles, and selecting a legend item highlights the related graph section.

**Simple Timeline:** The timeline is displayed horizontally, presenting key contents of the issue under each date for intuitive understanding. When clicking on an item in the timeline, it links to the original news article from which the key sentence was extracted.

**Dynamic Timeline:** The timeline is displayed horizontally, with an area graph on the y-axis showing the frequency of news articles mentioning issue contents. Interactive features, such as hovering over

the legend, highlight specific subtopics. This visual representation showcases when and how significantly specific subtopics emerge or recede in the discourse, offering an insightful view into the dynamic evolution of news topics. This graph's design draws inspiration from the concepts in [27] [28]. Clicking items in the timeline links to the original news articles from which key sentences were derived.

## 4.6. Envisioned Scenario

Alex is a marketing manager at a travel agency. Alex has been working hard throughout August to develop ideas and proposals for our upcoming fall travel promotions. Amidst this busy schedule, there had been no time to catch up on recent news. During a break, while discussing dinner plans and venues with colleagues, Alex learned from a coworker who preferred meat for the dinner menu because of concerns about Fukushima's Nuclear Wastewater discharge. Alex remembered reading news in July about the planned discharge but had not followed up on any developments since then.

Startled by this revelation, Alex quickly accessed a news service upon returning to their desk to catch up on the latest developments as of August 25, 2023. The top story in the 'World News' section was about initiating the contaminated water discharge from the Fukushima nuclear plant. Through the 'News Article Timeline' view, Alex discovered that the decision to release the contaminated water into the ocean was officially made on August 22, and the discharge began just two days later, on August 24, into the waters off Fukushima.

In the 'Subtopic View,' Alex learned about the schedule of the discharge and the mixed reactions of concern from local fishermen and residents. Realizing the potential worries this news might cause among the travel agency's clientele, Alex decided to preemptively verify the origin of seafood included in the menus of the travel packages. Furthermore, Alex planned to use the assurance of providing only safe ingredients as a key promotional point in the upcoming autumn travel campaigns, ensuring peace of mind for travelers booking through their agency.

# Chapter 5. User Evaluation

We conducted an experiment to evaluate whether our system could alleviate the frustration of being overwhelmed by news articles and help users understand the context of an issue. The user experiment evaluation methodology utilized quantitative and qualitative analysis techniques. Based on the experiment's results, we examined the effectiveness and usability of the system.

## 5.1. Participants

We recruited 22 participants (P01 to P22) through an online community and snowball sampling to recruit participants of different genders and ages. Of the participants, 59.1% (13) were female and 40.9% (9) were male. The age distribution was 40.9% (9) aged 19–25, 22.7% (5) aged 25–30, 13.6% (3) aged 30–35, and 22.7% (5) aged 35–40. (22 participants, male: N=9, mean=28.22, SD=5.72, female: N=13, mean=27, SD=6.58) None were news industry professionals (journalists, editors, reporters, news-related industry workers). Half of the participants (50%, 11) said they read the news five to seven times a week, 36.4% (8) said three to four times a week, and the remaining 13.6% (3) said one to two times a week.

## 5.2. Study Procedure

The experiment consisted of two tasks and a post-hoc interview: Task 1 was designed to evaluate the efficacy of the Subtopic View, and Task 2 aimed to assess the usefulness of the News Article Timeline View.

### 5.2.1. Tasks

In the experiment, we performed two tasks: in Task 1, participants were asked to select and read a news article about a single event and

then, with the news article interface closed, write down the main content of the event using keywords. In Task 2, participants were asked to select and read news articles published over multiple days about consecutive issues and then, again with the news article interface closed, write down the main content of those issues over time. While performing each task, participants were encouraged to read the news articles as they would normally do in their daily lives, rather than reading them thoroughly due to the experimental setting.

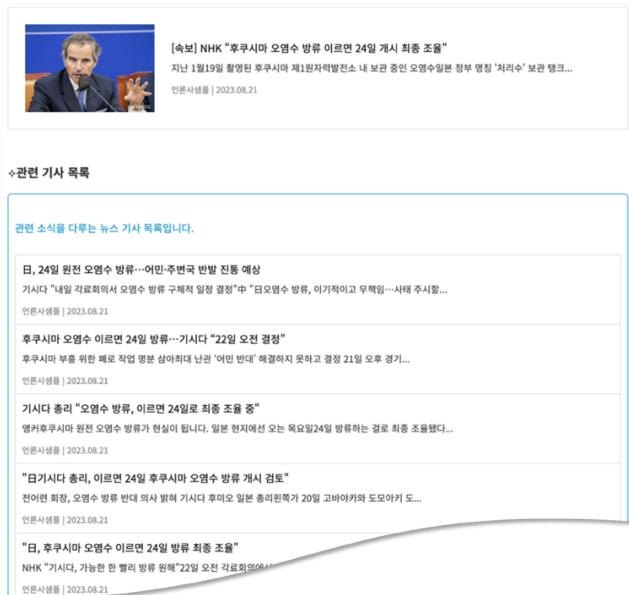


Figure 25: Control interface. Provides a list of news articles covering the same issue as the news article.

### 5.2.2. Control interface

To validate the effectiveness of News Snapshot, a control interface designed to resemble existing platforms, including Naver News home, was developed. Figure 25 illustrates the control interface used in the experiment. Participants performed the task using both the Control interface and News Snapshot in each task. In order to minimize individual differences among participants, the experiment was designed as a within-subject design, exposing each participant to all independent variable levels (interface effect). Neutral names 'System A' and 'System B' were used for the interfaces (System A: Control

interface, System B: News Snapshot) to avoid any bias that might influence the results.

### 5.2.3. Task-Specific News Allocation

Participants sequentially used Systems A and B for each task, with different news topics assigned for each system. Four news topics were prepared for each task. The experiment was conducted in Korea with Korean participants, and only Korean-language news articles were used to ensure language did not affect comprehension (Refer to Appendix. 4). In order to minimize the impact of prior knowledge about news topics on the experiment results, a pre-experiment survey assessed participants' prior knowledge of the news topics. News topics were assigned based on these results, with low prior knowledge topics randomly allocated to each task. Prior knowledge was collected using a 3-point Likert scale, and two news topics with low prior knowledge were randomly assigned to each task. If no matching prior knowledge level was available, for System B's effectiveness, topics with high prior knowledge were assigned to System A and those with low prior knowledge to System B. If all prior knowledge levels were the same, a balanced random allocation was made considering other participants' news topic assignments (Refer to Appendix. 5).

The experiment consisted of four sessions: {Task 1-System A, Task 1-System B, Task 2-System A, Task 2-System B} (Refer to Figure 26). Different news topics were used in each session, and one mandatory news article was provided per topic. After reading the mandatory article, additional news exploration was allowed. To ensure that reading time did not affect the results, a maximum of 5 minutes was allowed for reading the news articles for each event in Task 1, and a maximum of 10 minutes was allowed in Task 2 due to the large number of articles.

In our experimental design, we used a fixed sequence for testing the interfaces: System A (Control Interface) followed by System B (News Snapshot) for each task. This approach was adopted to enhance the reliability of our results, considering a few key aspects.

**Establishment of a Baseline with Control Interface:** Given the novel nature of System B (News Snapshot), System A (Control Interface) was consistently used first in each task to establish a baseline for user experience and performance. This approach provided a point of reference against which the novel interface's performance could be assessed, ensuring a more controlled and meaningful comparison.

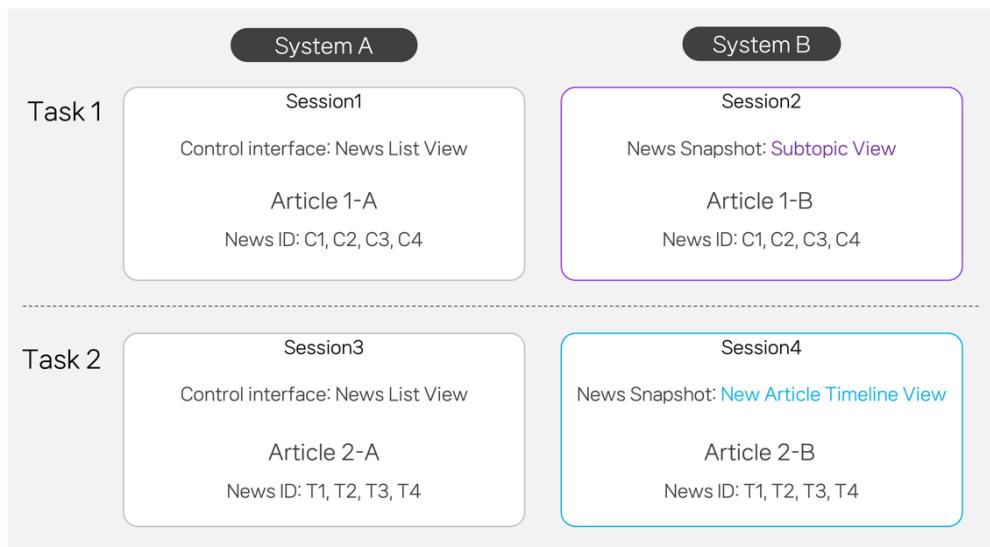


Figure 26: The experiment consisted of four sessions: {Task 1-System A, Task 1-System B, Task 2-System A, Task 2-System B}

While the fixed order is a departure from the standard practice of randomization, this methodological choice was made in order to compare the new interface to the control under consistent conditions. Acknowledging this deviation, future research should complement and extend the findings of this study by adopting a randomized design to explore further the impact of presentation order on user experience and performance in interface comparisons.

### 5.3. Measures

In each part of the study, participants engaged in a specific task in which they selected and read a news article from a list related to a

given issue. After reading, they were required to write down the article's main content and summarize it in keyword form.

After completing the task in each part, participants were prompted to complete a survey organized around a 5-point Likert scale. The survey questions were selected based on research referenced in [37]. Table 2 shows the survey questions used for Task 1 and Task 2. Six questions each were used in both tasks, with the first question in Task 1 being Q1-1 and the first question in Task 2 being Q1-2. The remaining questions (Q2-Q6) were the same for both assignments. Questions Q2 and Q3 used a technique called "reverse-scale questions." This approach is used to prevent respondents from accidentally giving the same response to all questions. In general, higher scores indicate more positive feedback. In reverse-scale questions, lower scores indicate less positive feedback. This technique effectively engages respondents and ensures more accurate and reliable data collection.

We also conducted a usability survey using a 5-point Likert scale to evaluate the interface, which was based on the study mentioned in [38] and consisted of the following dimensions: 'usefulness,' 'ease of use,' 'enjoyment,' 'effectiveness,' and 'overall satisfaction.' Table 3 shows the questions related to interface usability. The same questions were used for both Task 1 and Task 2.

After completing all tasks, a semi-structured interview was conducted to gather detailed participant feedback about their experiences with the tasks and interface usage. The questions posed to all participants were as follows, with additional follow-up questions based on their responses:

**Q1:** Were there any challenging or confusing moments while using System A or System B?

**Q2:** If you could continue using System A or System B, would you want to? If so, which one?

**Q3:** (For the system chosen in Q2) In what situations or on what news stories would you like to use this system?

**Q4:** Please share your opinions about the 'Subtopic View'.

**Q5:** Please share your opinions about the 'News Article Timeline View'.

Table 2. Survey Questions for task 1 and 2

No.	Questions	Task1	Task2
Q1-1	Effectively conveys the main content of the news article.	✓	
Q1-2	Adequately communicates changes in the main content of the issue.		✓
Q2	Necessitates further reading of news articles.*	✓	✓
Q3	It's difficult to decide which news article related to the issue to read.*	✓	✓
Q4	Enhances understanding of the news article (issue) content.	✓	✓
Q5	Reduces the time spent reading news articles.	✓	✓
Q6	Increases interest in the read news articles/issues.	✓	✓

\*Items 2 and 3 are "reverse scale questions." These types of questions are designed to prevent respondents from accidentally marking the same response to all items, resulting in more thoughtful and accurate feedback.

Table 3. Survey Questions for Usability

Aspect	Question
Usefulness	I find this interface useful for reading news articles and understanding their content.
Ease of use	This interface is easy to use when reading news articles.
Enjoyable	Using this interface was enjoyable.
Effective	This interface is effective in performing the task.
Overall Satisfaction	Overall, I am satisfied with this system.

## 5.4. Results

In this section, we performed a quantitative and qualitative analysis of participants' task performance and feedbacks. We also present an analysis of the post-task surveys that participants completed, focusing on each task. In addition, this section details the

usability evaluation of the system that participants rated after performing Tasks 1 and 2, respectively.

#### 5.4.1. Task performance

In Tasks 1 and 2 of the experiment, participants were asked to use both the control interface and News Snapshot to retrieve news articles about a specific issue and then wrote down the main content of the issue. Specifically, Task 1 covered a single day's worth of news articles about a specific event, while Task 2 covered multiple days' worth of news articles about consecutive issues.

In Task 1, we observed a marginal difference in the number of key content keywords between the control interface and News Snapshot (Control Interface: Mean=4.2, SD=1.6; News Snapshot: Mean=4.5, SD=1.8). However, a qualitative evaluation conducted through post-hoc interviews clearly demonstrated the usefulness of the newly developed interface. Most participants reported that the new interface allowed them to be aware of the key contents of an event beforehand, making it easier to comprehend the content while reading the articles. We found that the quality of key content provided by participants in Task 1 was generally similar across the board. This consistency was likely due to the nature of the task, which required participants to read news articles about a specific event that occurred in a single day. The content's simplicity and the experimental environment's specialized conditions may have encouraged participants to read the news more carefully and thoroughly.

In Task 2, we observed a marginal difference in the number of key content keywords between the control interface and News Snapshot (Control Interface: Mean=6.5, SD=2.8; News Snapshot: Mean=6.8, SD=2.4). However, a qualitative difference in key content keywords was observed. For Task 2, which required the use of the new interface, we observed a slight improvement in the ability to accurately represent the temporal context within the main content compared to the control group. The number of instances where the temporal context was correctly identified increased from 4 in the

control group to 7 in the group using the new interface. This slight improvement suggests that the new interface may have slightly helped users identify and represent the temporal elements of the content more accurately. Although accuracy did not improve significantly, it indicates that the interface is potentially effective in helping users better understand and communicate the temporal aspects of content, which is an essential element in understanding and summarizing news articles and similar types of content.

#### 5.4.2. Interface Usefulness Evaluation

In a survey administered at the end of each task, participants gave a generally positive evaluation of the News Snapshot (see Table 2, Figures 27 and 28). The graphs in Figure 27 and Figure 28 show that statements in Task 1, Q1-1, Q4, Q5, and Q6 had a higher percentage of "Strongly agree" ratings for News Snapshot than the control interface. Questions Q2 and Q3 were 'Reverse-Scaled Questions,' where lower scores indicate positive responses. In Figures 27 and 28, the responses to Q2 and Q3 were displayed with reversed values to facilitate easier comparison and analysis. This reversal ensured that, across all questions, higher scores consistently represented more positive responses, streamlining the process of evaluating and comparing participant feedback.

Only slight differences are observed for Question 2, which is about the need for reading more news articles. We assume that Task 1, which concentrates on events from a single day featuring less complicated news content, allows for easier comprehension with just one or two articles. This assumption is supported by the significantly better ratings for News Snapshot in Q2 of Task 2, which dealt with a greater number and complexity of news articles.

The survey results showed a more pronounced difference in Task 2. The experiment results for Task 2 rated News Snapshot as superior to the Control interface in all questions Q1-2, Q2-Q6. Notably, in Q3, 'Presents difficulty in choosing additional news articles to read,' Control interface scored very negatively, while News Snapshot received very positive ratings. The results of Q2, 'Necessity of further

reading of news articles,' and Q3, 'Presents difficulty in choosing additional news articles to read,' suggest that our system can alleviate the challenge of selecting news articles.



Figure 27: After completing Task 1, here are the survey results for the interface usefulness evaluation. The chart on the left, in purple, represents Control interface, and the chart on the right, in green, represents News Snapshot.

Table 4. The interface usefulness evaluation results for Task 1: According to Wilcoxon signed-rank test results, Q3, Q5, Q6 showed a significance level of \* $p<0.05$ , Q4 showed a significance level of \*\* $p<0.01$ )

Task	Question	W Statistics	Z value	p value
Task1	Q1-1. Effectively conveys the main content of the news article.	W=49.000	Z=-2.516	p=0.169
Task1	Q2. Necessitates further reading of news articles.	W=82.500	Z=-1.428	p=0.895
Task1	*Q3. It's difficult to decide which news article related to the issue to read.	W=34.000	Z=-3.003	p=0.041
Task1	**Q4. Enhances understanding of the news article (issue) content.	W=19.500	Z=-3.474	p=0.002
Task1	*Q5. Reduces the time spent reading news articles.	W=29.000	Z=-3.165	p=0.012
Task1	*Q6. Increases interest in the read news articles/issues.	W=38.000	Z=-2.873	p=0.033

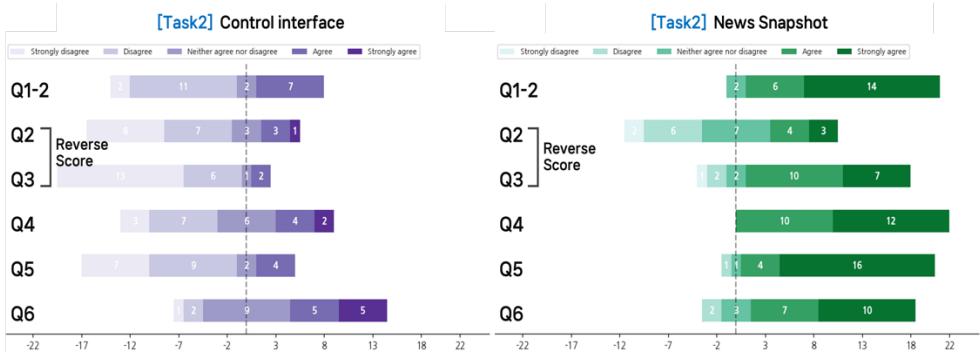


Figure 28: After completing Task 2, here are the survey results for the interface usefulness evaluation. The chart on the left, in purple, represents Control interface, while the chart on the right, in green, shows News Snapshot.

Table 5. The interface usefulness evaluation results for Task 2: According to Wilcoxon signed-rank test results, Q1-2, Q3, Q4, Q5 showed a significance level of \*\*p<0.01)

Task	Question	W Statistics	Z value	p value
Task2	**Q1-2. Adequately communicates changes in the main content of the issue.	W=0.0	Z=-4.107	p=0.000
Task2	Q2. Necessitates further reading of news articles.	W=49.5	Z=-2.500	p=0.063
Task2	**Q3. It's difficult to decide which news article related to the issue to read.	W=7.0	Z=-3.880	p=0.000
Task2	**Q4. Enhances understanding of the news article (issue) content.	W=3.0	Z=-4.010	P=0.000
Task2	**Q5. Reduces the time spent reading news articles.	W=0.0	Z=-4.107	p=0.000
Task2	Q6. Increases interest in the read news articles/issues.	W=47.0	Z=-2.581	p=0.088

Additionally, the evaluations of Q1-1, Q1-2, and Q4' Enhances understanding of the news article (issue) content' imply that our system can assist in identifying the main contents of overlapping news articles and understanding the context of issues (addressing RQ1 and RQ2). Q5, 'Reduces the time spent reading news articles,' received favorable ratings for both systems. This result suggests that our

system is valuable in enhancing the efficiency of information acquisition, thereby supporting RQ1.

We performed a Wilcoxon signed rank test to confirm the statistical significance of the survey results. When comparing the Control interface and News Snapshot for questions Q1–1 to Q6 in Task 1, all questions except Q1–1 and Q2 showed significance levels of  $p < 0.05$  or  $p < 0.01$  (Refer to Table 4).

In the case of question Q1–1, the p-value was recorded at 0.169, which exceeds the significance threshold of 0.01. Nevertheless, it is noteworthy that the proportion of responses indicating 'Strongly Agree' was higher for the News Snapshot interface by a factor of three than the Control interface. Question Q1–1, "Effectively conveys the main content of the news article," posits a scenario where the News Snapshot interface could be more beneficial, particularly with complex and challenging news articles. However, the news articles employed in our experiment were relatively straightforward, covering singular events. As the news articles used in the experiment were not complex issues, this may have prevented the News Snapshot interface from reaching its full potential in this context. For Task 2, when comparing the Control interface and News Snapshot for questions Q1–2 to Q6, all questions except for Q2 and Q6 showed significance levels of  $p < 0.01$  (Refer to Table 5).

#### 5.4.3. Interface usability evaluation

For each session of Tasks 1 and 2, we surveyed to assess the usability of the interface used in the tasks, and the results are shown in Figures 29 and 30. The results of the Wilcoxon signed rank test showed significant differences ( $p$ -value  $< 0.01$ ) for all aspects except 'ease of use' for Task 1, as detailed in Tables 6 and 7." Overall, News Snapshot received higher user ratings than the control interface, especially in Task 2, which focused on the "news article timeline." In Task 1, News Snapshot scored lower than the control on "ease of use," which was likely because the technical description of the system was difficult to understand.

[Task1] Comparison of Interface Usability

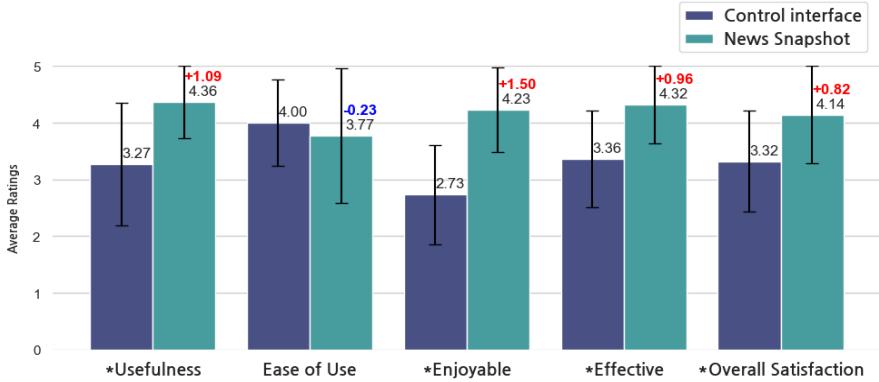


Figure 29: Usability comparison results for Task 1 performance: Our system scored better in Usefulness, Enjoyability, Effectiveness, and Overall Satisfaction. (According to Wilcoxon signed-rank test results, \* $p<0.01$ )

Table 6. Usability comparison results for Task 1: According to Wilcoxon signed-rank test results, all categories except for Ease of Use showed a significance level of  $p<0.01$

Task	Aspect	W Statistics	Z value	p value
Task1	Usefulness	W=19.000	Z=-2.722	p=0.003
Task1	Ease of use	W=60.500	Z=0.502	p=0.700
Task1	Enjoyable	W=6.000	Z=-3.696	p=0.000
Task1	Effective	W=33.000	Z=-2.688	p=0.003
Task1	Overall Satisfaction	W=33.000	Z=-2.688	p=0.003

[Task2] Comparison of Interface Usability

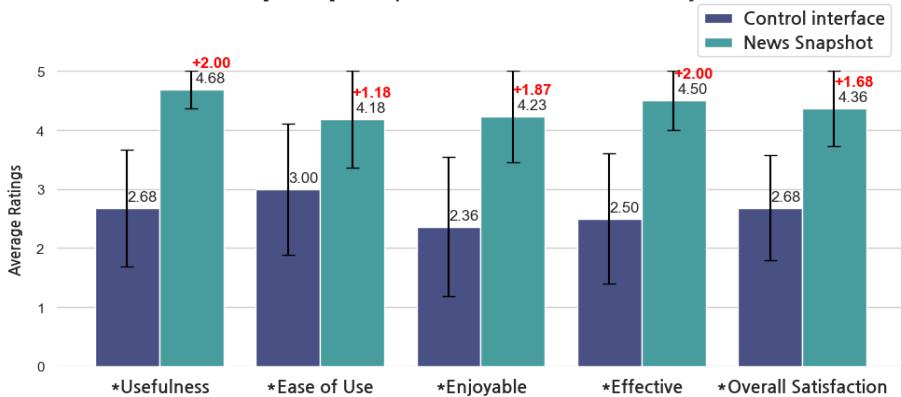


Figure 30: Usability comparison results for Task 2 performance: Our system scored better in Usefulness, Ease of Use, Enjoyability, Effectiveness, and Overall Satisfaction. (According to Wilcoxon signed-rank test results, \* $p<0.01$ )

Table 7. Usability comparison results for Task 1: According to Wilcoxon signed-rank test results, all categories showed a significance level of  $p < 0.01$ )

Task	Aspect	W Statistics	Z value	p value
Task2	Usefulness	W=4.000	Z=-3.875	p=0.000
Task2	Ease of use	W=17.000	Z=-2.637	p=0.004
Task2	Enjoyable	W=5.500	Z=-3.361	p=0.000
Task2	Effective	W=6.000	Z=-3.582	p=0.000
Task2	Overall Satisfaction	W=3.000	Z=-3.593	p=0.000

#### 5.4.4. Interview Analysis: Subtopic View

The Subtopic View of the news interface was found to reduce the burden of news consumption and increase detailed understanding of content. A key aspect highlighted by participants was the effect of integrating subtopics with related sentences.

Commenting on this integration, Participant P02 said, *"If there were only keywords, I might have read the news and moved on. But when the details were presented again in sentences, it made me want to dig deeper."* This observation suggests that the additional context provided by the sentences encourages more profound engagement with the news content beyond a glance at the keywords.

The approach of combining keywords with sentences was also perceived as both informative and emotionally considerate. Participant P17 appreciated this method and described it as a friendly approach, unlike some traditional news services that display keywords in hashtags or tip cards without additional information. Participant P16 noted that this approach is better than some news services that do not provide additional information and make it difficult to connect the keywords to the details of the article, especially if the user is not familiar with the news. P09 discussed the added value of having sentences accompanying the keywords: *"With just keywords, it's hard to understand the context they're used in, which can be curious and sometimes doubtful. But with the keywords followed by sentences*

*containing them, I can see the sentences and click on what interests me to read more.*" Meanwhile, Participant P04 pointed out that the quality of these representative sentences was essential and greatly impacted the overall experience with the news system.

Participant P07 shared a practical perspective on the utility of the representative sentences, saying, "*When I need to grasp an issue quickly, I think I would just read these key sentences. It's like getting a summary, so I found it convenient regarding information delivery.*" This highlights the Subtopic View's ability to provide quick and efficient access to the essence of the news. Other participants (P01, P03, P06) also found having a list of subtopic keywords and representative sentences helpful, likening it to reading a section of a summarized news article.

Participants were generally positive about the order of the Subtopics. Although the news articles presented in the experiment were simple, they thought that it would have been more effective with more complicated news. A critical insight came from an interview with P01, who mentioned, "*Just because a keyword is mentioned a lot doesn't mean it's important.*" This viewpoint advocates for a narrative structure in content organization over a mere emphasis on frequency or perceived importance. Participant P04 mentioned, "*If the subtopics are arranged by importance (larger cluster size first), people might only read the top 2-3 items and ignore the rest.*" Instead, arranging the content based on narrative encourages reading the entire content, which was seen as a benefit.

#### 5.4.5. Interview Analysis: News Article Timeline View

Participants expressed a high preference for the News Article Timeline View. All participants expressed a desire to continue using this feature. As noted by P05, P06, and P09, it was a helpful way to get the full context of an issue before diving deeper into a particular article. This timeline view made it easy to see the key takeaways and allowed them to make more informed choices about which additional

news articles to read later. Participant P02 mentioned, “*I didn't have to read the whole news articles to understand why things were happening the way they were, I just read the key points on the timeline.*”

However, there was one negative feedback about the timeline view. It was suggested that the efficiency of information acquisition provided by the timeline could be cognitively debilitating, and careful consideration should be given to how information is presented and processed. When presented with two ways of presenting the timeline view, participants favored a 'Simple Timeline' that allowed them to scan for highlights quickly. The 'Dynamic timeline' was visually appealing and engaging, but some participants needed help to utilize the information effectively.

# Chapter 6. Discussion

In this study, we proposed and validated the effectiveness of “News Snapshot,” a news system designed to process the extensive content of news articles and provide context through large language models. The “Subtopic View” and “News Article Timeline View” features of News Snapshot were aimed at reducing the information burden on readers and assisting users in quickly grasping the main content of an issue.

## 6.1. Benefits of Key Content Presentation

News Snapshot offers many benefits when covering multiple news stories that bring together various information on a particular topic. News Snapshot helps readers quickly grasp the subtopics of the news story by summarizing and highlighting key content. This summarization capability is crucial in environments where the volume of news can be overwhelming. News Snapshots have the potential to help alleviate news overload. News Overload, a form of Information Overload, occurs when exposure to news accumulates. According to 'Reuters Institute Digital News Report 2019', 28% of respondents reported feeling overwhelmed by the sheer volume of news [7]. News Overload is proportional to the frequency and quantity of news exposure [8][9][10][11][12]. For example, receiving push notifications at inappropriate hours or finding an overwhelming number of search results for specific keywords can contribute to this [13]. Excessive information can lead to feeling overwhelmed by the quantity of news and, in extreme cases, trigger news avoidance [10]. Compared to traditional news aggregator services, News Snapshot reduces the time to read a news article and increase understanding of an issue because they present key points first and users are free to decide whether to read further.

User evaluations have yielded new insights into the potential for mitigating bias in news consumption. Interviews revealed that our

interface was perceived as less biased than conventional news delivery methods. Where traditional news presentations might vary in their focus depending on the outlet[39], our interface, based on a comprehensive collection of news articles, has the potential to expose users to multiple perspectives.

An area for improvement in this study is the handling of outliers in the clustering process, which is crucial because it affects the comprehensiveness and accuracy of content analysis in the system. For example, if one or two articles discuss a new point of view in a dataset of thousands of news articles, this content may form a small cluster and be represented as a subtopic. However, it may be included in a larger cluster and go unnoticed. Future research should consider advanced text processing and clustering techniques that effectively handle these outliers. Such improvements could contribute to a more comprehensive and diverse news comprehension experience by ensuring that less visible but potentially critical perspectives are not overlooked in the news environment.

## 6.2. Enhancement of Timeline in News Articles

News Article Timeline View was designed to help readers understand the temporal evolution of an ongoing issue, even if they encountered the news story as it was happening. The timeline's time axis, therefore, corresponds to the publication date of the news story, helping readers understand when specific facts came to light and how they affected the development of the situation.

Another possible use for the News Article Timeline View is media analysis. The view can be used to understand how media outlets cover a particular issue. For example, if a series of corrections follows a scandal, the timeline can show the percentage of corrections compared to the initial coverage. Such an analysis can validate or dispel suspicions that the media may be aggressive in reporting controversial issues but passive in corrective or follow-up coverage. However, this type of analysis requires a substantial dataset of news articles. While

this study did not meet these requirements, future studies with rich news data could use this method to analyze patterns and trends in news coverage.

Most news coverage focuses on immediate or recent events, resulting in the timeline of a news article often coinciding with that of the event itself. However, there are instances where new facts about a long-past event emerge later, leading to a divergence between the news story's timeline and the event's actual timeline. In such cases, presenting the issue's timeline rather than the news article timeline proves more beneficial. Consequently, the extraction of temporal information from the texts of news articles for display alongside an event's timeline could significantly enhance the understanding of the event. This approach presents a valuable avenue for future studies to explore, aiming to improve the comprehension and contextualization of news events.

### 6.3. Extending Methods to Diverse Areas

We explored applying our methodology to a broader range of documents where it is essential to understand the evolution of the content of collections, such as historical documents and research paper collections.

Consider research paper discovery systems like Google Scholar or the ACM Digital Library. When hundreds of papers are displayed in response to a search query, it is difficult for users to identify key content topics. The Subtopic View in our system can cluster and visually present the main content of an entire collection of papers to help users quickly comprehend dominant arguments or common themes. Unlike systems like ResearchRabbit [45] that recommend related papers or visualize citation networks, our approach adds a temporal dimension to help understand knowledge as individual elements and parts of a story.

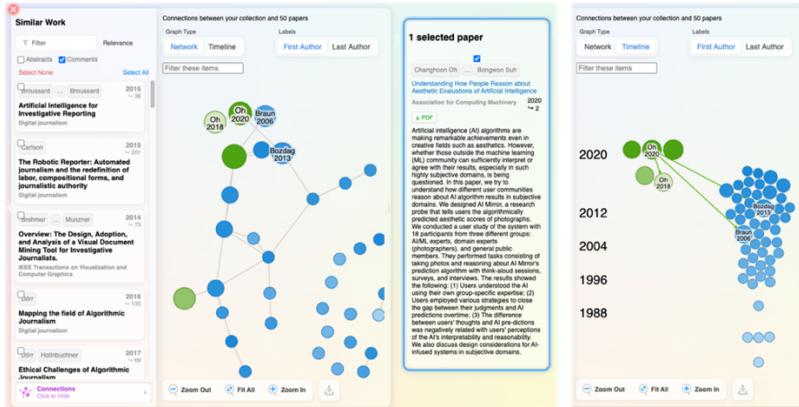


Figure 31: Visuals from ResearchRabbit [45] show similar work for a selected paper in network and timeline visualizations.

The ScienceOn platform [46] provides a Research Paper Timeline but only shows keywords in a word cloud format, needing more detailed context. Its citation-based timeline does not provide a comprehensive understanding of the overarching theme evolution within a research area.

Our system could also be used to construct individual chronologies. For example, if we maintain the news domain, we could compile articles about famous politicians or celebrities to create their chronologies. In the case of politicians, information such as election history, campaign promises, good deeds, and scandals can be summarized in a timeline so that voters can easily understand the politician's tendencies and interests.

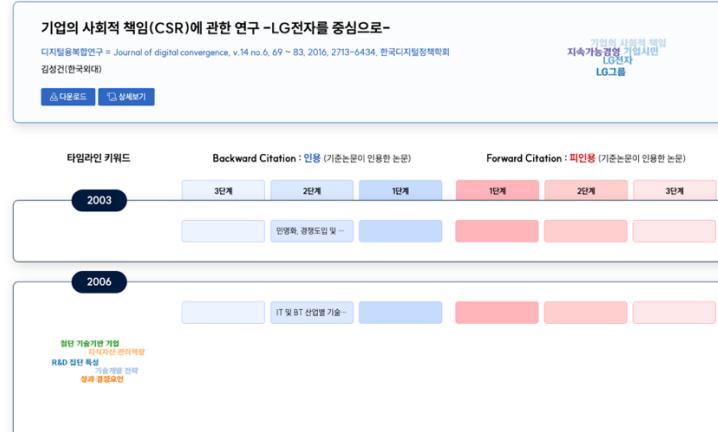


Figure 32: ScienceOn [46] provides a Research Paper Timeline, displaying backward/forward citation papers in chronological order.

## Chapter 7. Conclusion

In this study, we introduce a novel news aggregation system, “News Snapshot,” to address the problems in the digital news environment, such as the brevity, lack of depth, and overwhelming volume of digital news articles. News Snapshot aims to improve the digital news reading experience by performing two main functions: first, to help users quickly understand the key content among multiple news articles covering the same issue, and second, to help users quickly understand the progress and development of an issue over time. News Snapshot achieves this by employing an advanced clustering mechanism that utilizes sentence embedding from diverse articles, thereby delivering the key content for the user. It features two unique interfaces: the Subtopic View and the News Article Timeline View. The Subtopic View lets users grasp news articles' main points quickly, simplifying the comprehension process. In parallel, the News Article Timeline View provides a chronological framework, allowing users to place news stories in context and follow their development more effectively. This dual-view system facilitates a faster and more comprehensive approach to news consumption.

The experimental evaluations of News Snapshot have yielded promising results. The Subtopic View has proven effective in facilitating a preemptive understanding of news content. At the same time, the News Article Timeline View has been instrumental in enabling users to grasp the chronological progression and broader context of news stories. A usability comparison with a control interface revealed significant results, highlighting our system's effectiveness and potential for real-world application. Overall, News Snapshot not only aligns with current digital media consumption trends but also addresses the growing demand for news consumption that is both succinct and comprehensive.

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## Appendix 1. Dataset Sample (raw)

Filename: NewsGroup\_2023082514\_World.csv

The 'article' column contains the full text of news articles, but in this table, it has been abbreviated to 20 characters.

index	link	title	date	group_index	article
0	<a href="https://n.news.naver.com/mnews/article/025/0003302894?sid=104">https://n.news.naver.com/mnews/article/025/0003302894?sid=104</a>	日 오염수 방류에…中 "日수산물 수입 중단" 대만 "영향 미미"	2023. 08.24	0	24 일 오후 오염수 해양 방류를 시작...
1	<a href="https://n.news.naver.com/mnews/article/022/0003848614?sid=104">https://n.news.naver.com/mnews/article/022/0003848614?sid=104</a>	오염수 방류 버튼 눌렸다… 정부 “日 투명·책임감 있는 정보 공개 기대” [日 오염수 방류]	2023. 08.25	0	후쿠시마 오염수 방류 시작하루 약 4...
2	<a href="https://n.news.naver.com/mnews/article/003/0012050096?sid=104">https://n.news.naver.com/mnews/article/003/0012050096?sid=104</a>	日도쿄전력, 후쿠시마 오염수 24 일 오후 1 시 3 분 해양 방류 시작(종합 2 보)	2023. 08.24	0	바닷물로 희석 후 방류…기상 조건도 ...
3	<a href="https://n.news.naver.com/mnews/article/022/0003848475?sid=104">https://n.news.naver.com/mnews/article/022/0003848475?sid=104</a>	방류 버튼 누른 日… 정부 “수입 규제 유지” [日 오염수 방류]	2023. 08.24	0	후쿠시마 오염수 방류 시작韓총리 “日...
4	<a href="https://n.news.naver.com/mnews/article/020/0003516852?sid=104">https://n.news.naver.com/mnews/article/020/0003516852?sid=104</a>	수심 12m 밀 방류… 후쿠시마 앞바다 수면엔 아무 흔적 없어	2023. 08.25	0	日, 후쿠시마 오염수 방류 30년간 1...
5	<a href="https://n.news.naver.com/mnews/article/001/0014149887?sid=104">https://n.news.naver.com/mnews/article/001/0014149887?sid=104</a>	후쿠시마 오염수 방류 개시…"오늘 하루 200~210t 방출"(종합)	2023. 08.24	0	내년 3 월까지 보관 오염수 2.3 방...
6	<a href="https://n.news.naver.com/mnews/article/028/0002653574?sid=104">https://n.news.naver.com/mnews/article/028/0002653574?sid=104</a>	일본, 오염수 결국 바다로 쏟아냈다…올해만 3 만 t 방류 예정	2023. 08.24	0	24 일 오후 1 시부터 방류 시작…하루...

## Appendix 2. Dataset Sample (processed)

Filename: Sen4\_2023082514\_World.csv

article_index	link	title	date	group_index	sentence_index	sentence	file	tokens	keywords
0	<a href="https://news.naver.com/mnnews/article/025/003302894?sid=104">https://news.naver.com/mnnews/article/025/003302894?sid=104</a>	日 오염수 방류에…中 "日수산물 수입 중단" 대만 "영향 미미"	2023.08.24	0	0	24 일 오후 오염수 해양 방류를 시작한 일본 후쿠시마 제 1 원자력발전 소의 모습.	Sen2_2023082514_World.csv	['24 일', '오후', '오염수', '해양', '방류', '시작', '일본', '후쿠시마', '1 원', '자력발전소의', '모습']	[('후쿠시마 원전 예선 냉각수', 0.6594), ('후쿠시마 1 원자력발전소에서 24 일', 0.6515), (('후쿠시마 1 원자력발전소 앞바다', 0.6489), ('후쿠시마 1 원자력발전소 오염수', 0.6484), ('방류 후쿠시마 1 원자력발전소에서', 0.6474)]
0	<a href="https://news.naver.com/mnnews/article/025/003302894?sid=104">https://news.naver.com/mnnews/article/025/003302894?sid=104</a>	日 오염수 방류에…中 "日수산물 수입 중단" 대만 "영향 미미"	2023.08.24	0	1	일본 도쿄전력이 24 일 후쿠시마福島 제 1 원자력발전 소 오염수의 해양 방류를 시작했다.	Sen2_2023082514_World.csv	['AP', '일본', '도쿄전력', '24 일', '후쿠시마', '福島', '1 원', '자력발전소', '오염수', '해양', '방류', '시작']	[('후쿠시마 원전 예선 냉각수', 0.6594), ('후쿠시마 1 원자력발전소에서 24 일', 0.6515), (('후쿠시마 1 원자력발전소 앞바다', 0.6489), ('후쿠시마 1 원자력발전소 오염수', 0.6484), ('방류 후쿠시마 1 원자력발전소에서', 0.6474)]

## Appendix 3. ‘News Snapshot’ Full Screen

# News Snapshot

2020-08-25 ▾

## 후쿠시마 오염수 방류

[뉴스 1] 日, 후쿠시마 원전 오염수 해양 허용 개시..."오늘 하루 200~210t 방출" [관련 기사 102 개]

### 수요당

도쿄電力은 방사성 오염수를 처리하기 위해 ALPS 시스템을 사용하여, 배출된 오염수를 바다에 방류를 계획입니다.

이 작업은 약 4년 전 원전 폭발로 인해 해상이나 육상 기간은 불법입니다.

IAEA는 이 과정의 안전성을 검증하여 도너먼트 할 예정이며, 일본의 국민과 현지에서는 이에 대한 우려의 목소리가 나오고 있다.

### 뉴스가시 탐지라인

▼ 탐지라인은 아래에 표기되었습니다.

### 핵심 내용

▼ 최근 내용은 다음에 표기되었습니다.

핵심 내용과 관련 문장을 확인하세요.

리스트 항목을 클릭하면 해당 문장의 원문 링크로 연결됩니다.

#### 1 방류설 치러 및 폭력 발생

도쿄전력은 ALPS를 떠나 차례로 방사성 물질을 기준지 이하로 가르고, 이 물이 1,200m의 바닷물을 섞어 섬광수 농도를 최적화한 후 바다에 배출하는 계획을 세웠다.

#### 2 오염수 방류 첫 번째 및 영상

하루에 약 460㎘의 오염수를 바닷물로 희석해 엄청난 작업을 17시간 진행으로 오염수 7,800㎘를 바다로 내보내 계획일정은 미연지체 '전국 어업인들의 불만감은 커지고 있다.'

#### 3 방류 일정 및 영

오늘(이후 17일) 등장은 하루에 460㎘의 약 7,800㎘를 방류한 후 정차 그 것을 끌어 내린 39일까지는 전체 오염수 2.3 분량인 9만 1,200㎘를 바다에 흘려보낸다는 계획입니다.

#### 4 도쿄전력의 오염수 처리 방식

오염수 방류는 30년 가량 이어질 것으로 예상되지만, 청탁한 방류 기간은 확정치를 수 없는 상황이다.

#### 5 방류 기간 불법설

리야행 그로서 IAEA 사무총장은 "IAEA가 현지에 부임해 계속 검증할 것"이라고 말한 바 있다.

#### 6 IAEA는 검증과 검증

하루는 방사수 허용이 주제로 되어온 바지만 도쿄전력은 단행운제가설이 IAPS를 거쳐 후쿠시마 제1원전 부지 내 카랑 행정부에 보관된 오염수를 이날 오후 1시 30분부터 바닷물로 희석한 후 방출했다.

#### 7 여론 및 폭력 반발

내에는 방사수 허용은 30년 가량 이어질 것으로 예상되지만, 청탁한 방류 기간은 확정치를 수 없는 상황이다.

#### 8 방류의 배경

오염수 방류는 2021년 4월 23일 기사에서 당시 종이기 오염수의 해양 방류를 결정한 지 2년 4개월 만이며, 2011년 3월 11일 원전본대지진으로 후쿠시마 원전 사고가 발생한 지 12년 만이다.

### 뉴스 기사

▼ 관련 스태그램 992개

## Appendix 4. News Data Used in Experiment

This table contains information about the news articles prepared for each task.

Task	News ID	News Topic	Dates	Number of articles
Task1	C1	의대 정원 확대 이슈	2023.10.13	26
Task1	C2	심야 집회 금지 방안	2023.09.22	56
Task1	C3	축협 조합장의 직원 폭행	2023.10.06	17
Task1	C4	불법무기류 자진 신고	2023.08.31	21
Task2	T1	후쿠시마 오염수 방류	2023.08.21-10.05	1319
Task2	T2	교권 침해 및 교사 파업	2023.08.18-08.25	169
Task2	T3	Jamboree 2023	2023.07.29-10.20	1201
Task2	T4	홍범도 장군 흉상 철거	2023.08.25-09.08	515

## Appendix 5. Task-specific News Allocation

This table represents the distribution of news articles to participants for each specific task during the User Evaluation.

Participants	Task 1		Task 2	
	System A	System B	System A	System B
P01	C1	C2	T1	T2
P02	C2	C3	T3	T1
P03	C1	C2	T2	T3
P04	C3	C1	T2	T1
P05	C3	C2	T1	T3
P06	C2	C3	T3	T2
P07	C1	C3	T3	T1
P08	C2	C1	T1	T3
P09	C2	C3	T1	T3
P10	C1	C3	T1	T3
P11	C2	C3	T3	T1
P12	C3	C4	T2	T4
P13	C4	C2	T3	T1
P14	C2	C3	T1	T3
P15	C4	C2	T4	T1
P16	C3	C4	T4	T2
P17	C4	C3	T3	T4
P18	C4	C2	T1	T4
P19	C3	C2	T4	T1
P20	C3	C2	T2	T4
P21	C2	C4	T4	T2
P22	C3	C4	T4	T3

This table represents the distribution of news to Systems A and B, organized by each task.

News ID	Task 1		Task 2	
	System A	System B	System A	System B
C1	4	2		
C2	7	8		
C3	7	8		
C4	4	4		
T1			7	7
T2			4	4
T3			6	7
T4			5	4

## Abstract in Korean

뉴스 산업이 발달하면서 뉴스 독자의 뉴스 소비 방법에도 많은 변화가 생겼으나, 여전히 온라인에서 텍스트 기반의 뉴스 기사에 대한 소비는 꾸준히 이루어지고 있습니다. 하지만 뉴스 기사의 단편화, 뉴스 기사의 깊이 부족 및 너무 많은 뉴스 기사의 수와 같은 문제점들은 디지털로 뉴스 기사를 읽는 독자들에게 불편함을 주고 있습니다.

이 연구는 뉴스 산업의 발전과 뉴스 소비 패턴의 변화로 인해 발생하는 이러한 문제점 완화하기 위하여 새로운 뉴스 시스템 '뉴스 스냅샷'을 제안합니다. '뉴스 스냅샷'은 독자들이 뉴스 기사의 핵심 내용과 이슈의 맥락을 이해하는 데 도움을 주도록 설계되었습니다. '뉴스 스냅샷'은 동일한 사건에 대해 다수의 뉴스 기사에서 주요 내용을 식별하여 독자에게 핵심 포인트를 전달합니다. 이는 지속적인 이슈에 따라 주요 내용을 타임라인에 따라 시각화함으로써, 독자들이 이슈에 대한 주요 내용의 흐름을 빠르게 파악할 수 있게 합니다. 우리 시스템은 문장 임베딩 및 클러스터링 방법을 사용하여 뉴스 문서 컬렉션에서 주요 내용을 찾고, 웹페이지로 구현된 인터페이스로 제공합니다.

22 명의 참가자와 함께 한 실험을 통해 이 시스템의 효과와 사용성을 검증했습니다. 우리는 뉴스를 읽고 주요내용을 키워드로 작성하는 작업, 설문조사, 그리고 사후 인터뷰를 진행했습니다. 그 결과, 우리 시스템은 뉴스 기사를 읽는 부담을 줄이고 이슈의 주요 포인트를 이해하는 데 도움이 되는 것으로 나타났습니다. 사용성 평가를 통해 기존 시스템을 모방한 컨트롤 인터페이스와의 사용성 비교에서도 '뉴스 스냅샷' 더 가치 있고 실용적인 것으로 드러났습니다.