**Ⅰ. Introduction**

Advent and development of Internet technology greatly affected human society. Internet technology made production and consumption of data easier. This affected the whole environment of media including news media. Before wide spread of internet, only mass consumption of media was available through unidirectional transmission of signal. However, writing and sharing of data became easier and mass production became available as era of internet began.

Also, Internet technology enhanced dependency of news media. In the past, news media were distributed by producers. For example, broadcasting station creates its own news and broadcasts it. On the internet however, news data are typically distributed by portal website except for some big and authorized publishing corporation (Wi-Geun Kim, 2014). Changed occurred from internet technology greatly affected journalism ecosystem.

Portal playing a role of distributor cuts expense for producing news since producers have no concern on distribution expense. Due to reduction of cost, news media once were exclusive and gate-keeping, now started to become gate-opening (Kyungmo Kim, 2012). As a result, news creators increased, and news media became exceedingly abundant.

Due to change in ecosystem like mentioned above, there are lots of news sources and contents on web nowadays. Most of them are dependent to portal websites (Yeo-kwang Yoon, 2104). Dependency on portal website of news creators created power imbalance between producers and distributors (Haeyeop Song, Jay Yang, 2017). From power imbalance, producers had to cater the distributors’ need. On website, more click means more money. So, all those news producers tend to create short, quick news to compete with their competitors; to get more clicks from users and suit distributors’ need. “Competition of click” led to creation of abundant and low-quality news contents focusing on temporary issues. Therefore, with online news it’s becoming harder to see the whole picture of an event. For example, there are lots of news regarding “Burning sun” in South Korea. “Burning Sun” is a club in Gangnam, South Korea. “Burning Sun” started to get spotlight by assault incident. Burning sun issue got worse as more scandals like “Selling drug”, “Sexual favors”, “Hidden camera”, and “Back-scratching relationship between politician and police” being revealed to public (Joan, MacDonald 2019). Burning Sun scandal has so many sub-issues and it’s actually impossible to follow what has happened from the start since online news media only focuses on minor and temporary issues of Burning sun. In other words, it’s hard to see the wood for the trees from online news media. This paper was started from this kind of concern and “timeline news algorithm” is designed to ease this problem. There are test cases with Burning Sun issue and would be able to check out how much this algorithm would help to understand the Burning Sun issue.

As news on online media has limitations on understanding the whole issue, there is a need for news contents that tells overall flow of an event. These kinds of news are called “story telling news” (Ji-Yeon, Kim and Jae Young, Yun 2015) but there is no service that consistently provides timeline news. To suit those needs, this research proposes “Timeline news algorithm”, connects particulated news into one whole story line to help people see the whole picture of an issue. “Timeline news algorithm” uses “linear storytelling” structure. Linear story telling structure (Eunyoung, Kang 2010) is easy to comprehend series of information on web interface as information is provided intuitively. “Linear story telling” structure is a structure that tells what happened in time series. Since “Linear story telling” structure provides information in chronological order, it’s very intuitive and simple. These characteristics would improve peoples’ understanding of an issue. Also, it uses Open API made by Korean Press Foundation to get several news data. Algorithm covers the “sub-issues” from time to time about certain issue. This will enable readers to follow updating sub-issues (or minor scandals regarding issue) along with the whole picture of event.

To briefly show what this algorithm does, following is expected result of “timeline news algorithm”. “Timeline news algorithm” will make multiple number of time interval blocks. Each block has its own “sub-issue”. For example, according to this algorithm, first time interval of “Burning Sun” issue has assault case as sub-issue from 2019-01-29 to 2019-02-04. Like this, algorithm will disassemble one big issue into multiple number of sub-issues. This will enable users to better understand about issue efficiently.

**Ⅱ. Algorithm Design**

For better understating about this algorithm’s structure, refer to Figure 1. Figure 1 is how this algorithm result should look like. There are two axes in the screen. Both axes are chronological timeline. Horizontal axis helps people to see the whole event (all the sub-issues) at once. Vertical axis helps people to read specific articles which would be helpful for understanding details about sub-issues.

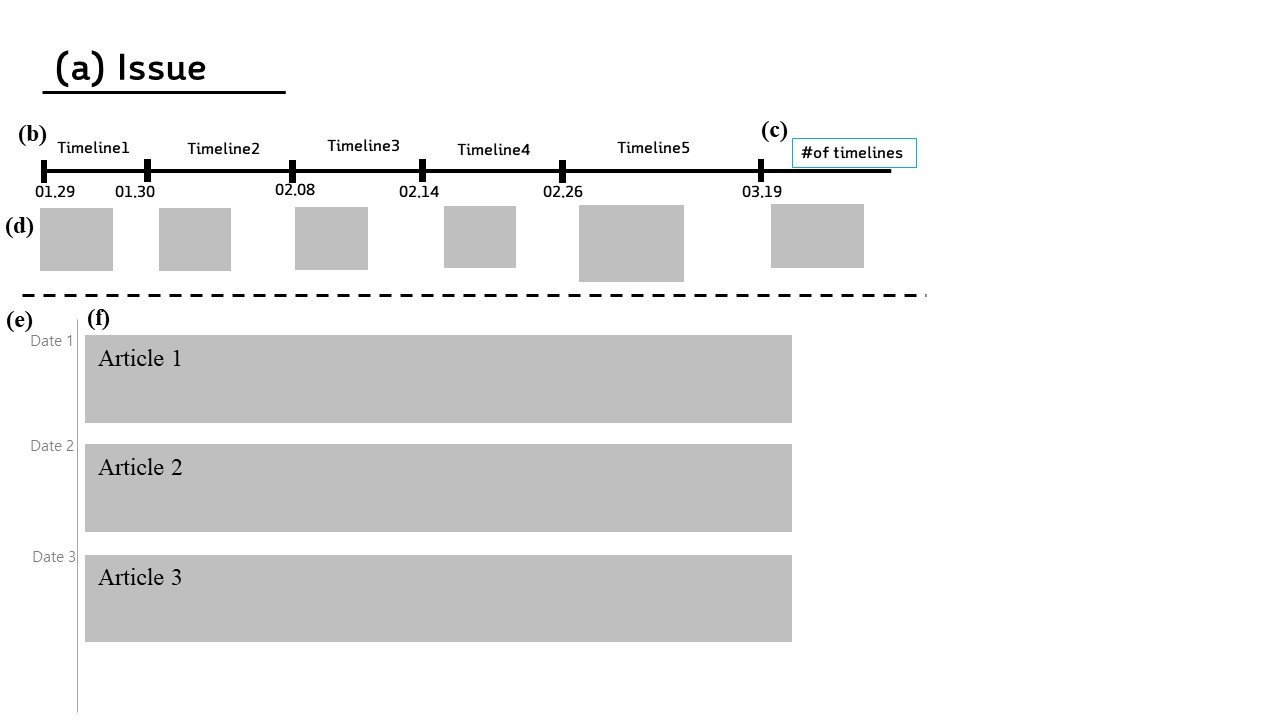


Figure 1. (a) Issue from input, (b) Horizontal timeline, (c) Number of timeline from option, (d) Related picture of each timeline, (e) Vertical timeline with dates, (f) News articles for each dates.

This section tells how algorithm works. Algorithm is composed of four big parts. First part is extracting related keywords of each dates. #2 of this chapter will cover extracting related keywords of each date. Second part is comparing keywords with adjacent dates and expanding them into one time interval if they deals with same sub-issue. #3 and #4 of this chapter will cover comparing keywords and expanding time interval. Third part is prioritizing time interval blocks and erasing blocks that are considered less significant. #5 and #6 of this chapter will cover prioritizing process but this part will not will activated if user set rephrasing option “off”. Last part is news searching part. #7 will cover this part. #1 of this chapter works as main function of this algorithm. #1 contains all other processes. From Figure 2 in the #1, there is a flowchart that tells general flow of this algorithm.

1. Creating a Story line of a News Issue

Getnews function works as main function for creating timeline news. This function returns timeline news data. Expected result of this algorithm is each time interval having its own sub-issue (different with other interval’s sub-issue). To be more specific, there will be multiple time intervals and there will be three relatedbn

keywords and news articles in each time interval. Timeline is divided as new sub-issue arises; dividing phase.

This function will return given number (option) of time intervals. If you set option as -1, function will return all the chunks it makes. This ability was made to prevent the timeline from being long-winded. If you use this option, function will return period chunks that were spotlighted most by using sum of each time interval’s weight sum. This option would enable users to see whole issue briefly but there would be some missing sub-issues since time intervals with less weight is removed.

To follow the flow of function, refer Figure 1 and Table 1. After **keywordextract** function in Figure1, algorithm will return list of elements and each element will have date and relevant keyword of “Burning Sun”. Of course, related keywords will gradually change as new sub-issues arise.

After **Phasedivide** function, all the dates will be combined to multiple numbers of time intervals. Intervals are made if adjacent dates seem to have same sub-issue. Since dates in the interval deal with common issue within a time interval, it is likely that dates in same interval have common related keyword. To handle multiple number of common related keywords, **Keyword\_Integrate** function put common related keyword together within time interval (weights will be added).

If rephrasing option is set to -1(off), then algorithm will jump to **NewsSearch** function. **NewsSearch** will search news for every time interval. When searching news, time period, issue, and three related keywords of the interval will be given. By adding three related keywords for search option, search result will show relevant news contents that contains those related keywords (or sub-issue).

If there is a rephrasing option (positive integer N), algorithm will add up all the related keywords’ weight in each time interval and compare the value of weight sum of each interval. N time intervals with highest weight sum will be the input of **NewsSearch** function.

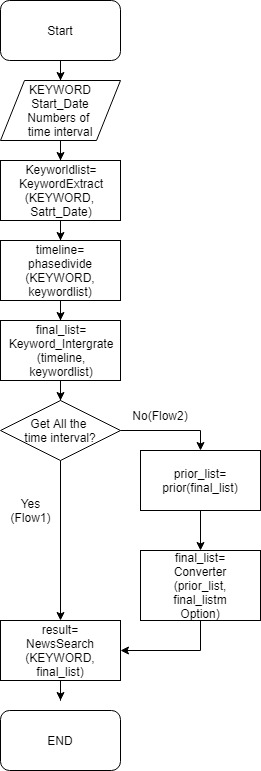


Figure 2 This figure shows flow of algorithm from input to result.

Parameter:

Issue: Single phrase. Must be phrase that one wants to know about.

BEGIN\_SEARCHING: Date that one wants to Begin\_searching search about Issue.

OPTION: Timeline option. Can limit the number of phases. -1 to set this option off.

Table 1. This function gets input from user and return result to users.

|  |
| --- |
| 1.GetNews function |
| Input: Issue, BEGIN\_SEARCHING, OPTION  1: keywordlist ← **keywordextract**(KEYWORD,BEGIN\_SEARCHING)  2: timeline ← **phasedivide**(KEYWORD, keywordlist)  3: final\_list←**keyword\_Integrate**(timeline, keywordlist)  4: if (rephrasing option is off)  5: prior\_list←**prior**(final\_list)  6: input\_list←**converter**(prior\_list,final\_list, option)  7: article←**NewsSearch**(KEYWORD, input\_list)  8: else  9: article←**NewsSearch**(KEYWORD, final\_list)  10: return article |

1. Extracting Related Keywords of Date

This is the function that collects related daily keywords and its weights. This function used “timeline API” and “wordcloud API”. “Timeline API” checks number of news posted on a designated day with given issue like “Burning Sun”. “Wordcloud API” uses both “Term Frequency” algorithm and “Inverse Document Frequency” algorithm to get related keywords and its weight.

By using “timeline API”, date with less than 10 posted regarding issue was not included in keyword extracting process (Considering that date has less or no relevance with given issue). Also getting rid of dates like this would make algorithm to finish timeline if case is closed.

\*At Table 2, **detect function** will return dates in list format. If less than 10 news were posted with Issue, that date will not be included in the list. This function uses “timeline API” in Table 3.

\*At Table 2, **getwordcloud function** collects related keywords and its weight. This function uses “wordcloud API” in the Table 4.

Table 2. This function extracts relate keywords on daily basis.

|  |
| --- |
| 2.Keywordextract function |
| Input: Issue, BEGIN\_SEARCHING  Output: List of “date and that date’s related keywords”  1: labels ← **detect**(Issue, BEGIN\_SEARCHING)  2 for all elements in labels:  3 date ← get date information from element  4 result ← **getwordcloud**(Issue, date)  5 append result to final  6 return final |

Output example: [[2019-03-03, {hotdog: 32.33, pizza:121}], [2019-03-04, {tomato: 10, rice: 65.1}]]

About number beside each related keyword is weight.

2-1. Detecting Relevant Dates with Keyword

Uses “timeline API”. The variable timeline in line 2 of table 3 will have list object with dates and number of news posted as a return value of API request. This function is used to detect relevant dates with given issue.

Table 3. This function detects number of news posted with given Issue “timeline API”.

|  |
| --- |
| 2-1.detect function |
| Input: Issue, BEGIN\_SEARCHING  1: Get today’s date  2: timeline ← **timeline API request**(Issue, from BEGIN\_SEARCHING until today)  3: for all elements timeline”  4: if (news posted >= 10):  5: append element to result  6: return result |

Output example: [2019-01-01, 2019-01-02, 2019-01-04, ....2019-05-01]

2-2. Getting Related Keyword with word cloud API

This function uses “wordcloud API”. This function will return a date, related keyword of that date, and its weight. This function is designed to request daily wordcloud in this algorithm.

Table 4. This function gets related keywords and its weight by using “wordcloud API”.

|  |
| --- |
| 2-2. getwordcloud function |
| Input: Issue, date  1: wordcloud ← **wordcloud API request**(Issue, date)  2: wordcloud ← sort related keywords in descending order with weights  3: if(more that 10 keywords):  4: remove rest of keywords  5: return wordcloud |

Output example: [2019-01-01, {angry tomato: 23, blue paper: 4}]

1. Expanding size of time interval based on sub-issue by comparing adjacent dates

Reminder: keywordlist (input) is list of “dates, related keywords and its weights”. Related keywords on each date will be sorted in descending order of weight.

This function iterates through each date and compare related keywords with adjacent dates’ related keywords. If there are similar, function considers those dates deal with same sub-issue and combine them into one time interval. At line 3 in Table 5, there is a condition for checking similarity. If list of related keywords of date “n-1” contains top three related keywords of date “n”, algorithm considers that those dates deals with same sub-issue. If sub-issue has not changed for one week, function intentionally divides time interval to see more details about that sub-issue. Purpose of intentional division of time interval is to prevent time interval from being long-winded.

Goal of this function is to divide whole events into minor stages (or sub-issues). This will enable users to see the whole event in several significant chunks. This will enhance understanding of whole event. To give an example with “Burning Sun”, this algorithm should create new time interval if main sub-issue changed from “hidden camera” to “drug selling” as new scandal arises.

Table 5. This function expands dates into time intervals by comparing related keywords of adjacent dates.

|  |
| --- |
| 3. Phasedivide function |
| Input: keywordlist  Output: list of starting dates of each time interval  1: initialize counter to 7  2: for all elements in keywordlist:  3: if (one of i th date’s top 3 keyword is in the i-1 the date’s keywordlist):  4: reduce counter  5: if (counter is zero):  6: append element’s date into resultlist  7: else:  8: append element’s date into resultlist  9: reset counter  10: return resultlist |

Output example: [2019-03-01, 2019-03-05, 2019-03-12]

Each date represents the starting date of each time interval.

1. Integrating Daily Related Keywords into period related keywords

timeline is return value of phasedivide function (previous function). Goal of this function is to integrate daily dates and keywords into time interval unit keywords and dates. Therefore, return value will be a list of periods (not date) and that period’s related keywordlist. In this process, list of multiple dates” related keywordlists will be integrated and ordered in descending order of weight again.

For example, if there is a time interval from 2019-01-01 to 2019-01-03.

2019-01-01’s related keywords were {“a”:132.1, ”b”:33 }

2019-01-02’s related keywords were {”b”:100, “c”:7.3 }

2019-01-03’s related keywords were {“b”:150.4 , “a”:14.1 }

Then, this time interval will be 2019-01-01 to 2019-01-03 related keywords of {“b”:283.4, “a”:146.2, “b”:133}

Table 6. This function handles same keywords within a timeline by adding its weights.

|  |
| --- |
| 4. Keyword\_Integrate function |
| Input: timeline, keywordlist  1: for i in range(1, len(timeline)):  2: start ← timeline[i-1]  3: end ← timeline[i]  4: weight←{}  5: for j in range(start+1, end, 2): #temp will be the daily keywords  6: temp←keywordlist[j] #and weights between start and end.  7: for k in range(0, len(temp)): # iterates through daily keywords  8: if (temp[k] in list):  9: add weight(value) to pre-existing keyword key  10: else:  11: add new keyword(key)  12: sort key values of weight in descending order of weight  13: append its weight to result  14: return result |

1. Ranking Period Blocks with Sum of Weight Value

Each time interval’s weights of keyword are added in this function temporarily. Then function will compare the sum value of multiple number of intervals of weight and rank time intervals. Weight is a value that reflects how much a certain word was referred with given Issue. So, related keyword with higher value can be seen as frequently mentioned sub-issue. So, weight could be interpreted as peoples’ interest about certain keyword. By comparing sum of these value, function will identify which time interval’s keyword had more attention. With this, algorithm will prioritize the multiple time intervals considering higher weight sum dragged more attention to public.

If there is OPTION value of positive integer (rephrasing function), algorithm will go through this function to check which time interval to return. Time interval block with relatively low sum value would be excluded at return value.

This will be executed through two functions; Prior() and Converter() at Table 7 and 8. Prior() will add the weight values and Converter() will delete the time intervals that are not in the rank.

Return value of Keyword\_Integrate function becomes the input value of Table 7’s function.

Table 7. This function adds all the weights of related keyword within each time interval.

|  |
| --- |
| 5. Prior function |
| Input: final\_list  1: prior←[None]\* len(final\_list)  2: for i in range(0, len(final\_list)):  3: if(i←←even):  4: prior[i] ← final\_list[i] #copy period value  5: else:  6: prioir[i] ← sum of weights in final\_list[i]  7: result ←copy “prior”  8: for i in range(0, len(result\_list))  9: set first(1st value) and last(len(result\_list)th value) to 0  10: rank sum of weight and replace sum with its ranking  11: return result |

1. Deleting Period Blocks that are not in the rank (option)

Prior\_list is return value of prior function at Table 7. Like mentioned above, this function deletes the time intervals that are not in the rank.

Table 8. This function selecting few timelines that has biggest weight sum.

|  |
| --- |
| 6. Converter function |
| Input: prior\_list, final\_list, option  1: iterator ← len(final\_option)  2: iterator ← change to option if option is smaller than len(final\_option)  3: result\_list←[None]\*(2\*iterator) #initilalize list with enough size  4: save first two element of final\_list to first two space of result\_list  5: save last two element of final\_list to last two space of result\_list  6: index←3  7: for i in range (3, len(final\_list)-2, 2):  8: if(prior\_list[i] < number-2): #checks if ranking of each period suits the option  9: result\_list[index] ← final\_list[i]  10: result\_list[index-1] ← final\_list[i-1]  11: index+←2  12: return result\_list |

1. Searching News with Given Period, Keywords

This function uses “Search API” in the line 9 of Table 7. Purpose of this function is to search news with each time interval. NewsSearch function will search news with given period, Issue, three relate keywords with big weight. Then, news that contains those keywords will be found. News that contain those keywords well are considered to reflect time interval’s sub-issue.

Table 9. This function searches news with given input.

|  |
| --- |
| 7. NewsSearch function |
| Input: Issue, final\_list  1: for all element in final\_list:  2: if (element is date):  3: start ← get start date from element  4: end ← get end date from element  5: else:  6: word ← [Issue, element’s top 3 keywords]  7: article ← **search**(start, end, words)  8: append article to result  9 : return result |

7-1. Searching News with Searching API

Used “Search API” to search for news with given period and words. In this algorithm, API request is sent with period, Issue, other three keywords. Then API is set to return most related 2 news. When doing test case, all other information like publisher and name of reporter was excluded since the core purpose of this algorithm is to understand what happened (contents of news were what mattered the most when understanding a topic).

**Ⅲ. Case Study**

**About test cases**

There are two test cases about “Burning Sun” below. First one is making timeline without rephrasing. Second one is making timeline with 10 time intervals. Return value of this algorithm should have multiple time intervals and each time interval has three related keywords and two news articles. For several reasons, article was skipped in this paper. Algorithm was set to return two news articles each that contains keywords well.

The purpose of test case is to check if this algorithm reorganizes news well for the understanding of an issue (using timeline). Article is the simple result of news search using issue and related keywords. So to check the effectiveness of this algorithm, it is important to check the related keywords of each time interval. To boost readers’ understanding of test case result, title of each time interval was included in Table 10 and 11.

To help verify effectiveness of this algorithm, there are a title of articles (result of this algorithm) at the back. From this, reader would be able to check if this algorithm helps to understand the whole story line without spending much time.

1. Case 1

Table 10 is the result of given input above (without news article). According to Table 10, there were 35 time intervals in total until the test day. This means that “Burning Sun” can be divided into 35 meaningful intervals since each intervals has similar sub-issue in it.

Table 10. It is result on “Burning Sun” without rephrasing option and got 35 time intervals.

|  |  |
| --- | --- |
| Time interval | Related Keyword |
| 1 | 폭행 사건 (Assault case), 성추행(Sexual harassment), 성폭행(Sexual assault) |
| 2 | 성관계 동영상(Sex tape), 성폭행(Sexual assault), 이문호 대표(CEO Lee)[[1]](#footnote-1) |
| 3 | 성관계 동영상(Sex tape), VIP룸(VIP room), 참고인 신분(Witness) |
| 4 | 마약 투약(Drug administration), 애나(Anna)[[2]](#footnote-2), 유착 의혹(Suspicion of collusion) |
| 5 | 경찰관(Police officer), 유착 의혹(Suspicion of collusion), 압수수색(Search and seizure) |
| 6 | 성접대(Sexual favor), 이문호 대표(CEO Lee), 사내이사(In-house director) |
| 7 | 성범죄(Sexual offense), 해시태그(Hash tag), 물뽕(GHB)[[3]](#footnote-3) |
| 8 | 이문호 대표(CEO Lee), 유착 의혹(Suspicion of collusion), 마약 투약(Drug administration) |
| 9 | 유착 의혹(Suspicion of collusion), 마약 투약(Drug administration), 탈세 의혹(Suspicion of tax evasion) |
| 10 | 성접대(Sexual favor), 성범죄(Sexual crime), 각종 의혹(Various suspicions) |
| 11 | 이승현(Seung Hyun Lee)[[4]](#footnote-4), 아레나(Arena)[[5]](#footnote-5), 성접대 논란(Sexual favor) |
| 12 | 정준영(Jeong Jun-young)[[6]](#footnote-6), 유착 의혹(Suspicion of collusion), 경찰총장(Police chief) |
| 13 | 현직 경찰관(Policeman in service), 피의자(Suspect), 직무유기 혐의(Suspicion on dereliction of duty) |
| 14 | 김학의(Kim Hak Yi)[[7]](#footnote-7), 구속영장(Arrest warrant), 정준영(Jeong Jun-young) |
| 15 | 폭행 사건(Assault case), 경리실장(Chief accountant), 경리업무(Accounting work) |
| 16 | 린사모(Linsamo)[[8]](#footnote-8), 김학의(Kim Hak Yi), 지창욱(Ji Chang-wook)[[9]](#footnote-9) |
| 17 | 유착 의혹(Suspicion of collusion), 로스쿨 교수들(Professors at law school), 서강대(Seo-gang university) |
| 18 | 김학의(Hak-ui Kim), 유착 의혹(Suspicion of collusion), 황하나(Hana Hwang)[[10]](#footnote-10) |
| 19 | 멤버 승리(Seung-Ri)[[11]](#footnote-11), 정준영(Jeong Jun-young), 삼합회(Triad) |
| 20 | 정준영(Jeong Jun-young), 연예인(Celebrity), 마약 투약 혐의(Suspicion of drug administration) |
| 21 | 현직 경찰관(Policeman in service), 중고차(Used car), 전직 경찰(ex-police) |
| 22 | 정준영(Jeong Jun-young), 성관계 동영상(Sex tape), 김상교(Sangkyo Kim)[[12]](#footnote-12) |
| 23 | 유리홀딩스(Yuri Holdings)[[13]](#footnote-13), 전원산업(Jeonwon industry)[[14]](#footnote-14), 가수 승리(SeungRi) |
| 24 | 이승현(SeungHyun Lee), 몽키 뮤지엄(Monkey Museum)[[15]](#footnote-15), 가수 승리(SeungRi) |
| 25 | 마약 투약 혐의(Suspicion of drug administration), 구속영장(Arrest warrant), 애나(Anna) |
| 26 | JYP(JYP), 엔터테인먼트 업종 주가(Sotck price of Entertainment company), 가수 승리(SeungRi) |
| 27 | 성폭행(Sexual assault), 정준영(Jeong Jun-young), 박한별(Han Byul Park) |
| 28 | 마약 투약 혐의(Suspicion of drug administration), 전원산업 (Jeonwon industry), 이문호(Mun Ho Lee) |
| 29 | 장자연 사건(Jayeon Jang case)[[16]](#footnote-16), VIP, 등지 소각팀(Incineration team) |
| 30 | 경찰 안팎(Inside and outside the police), 경찰청(Police agency), 마약대응 조직(Drug response organization) |
| 31 | 연예인들(Celebrities), 구속영장(Arrest warrant), 불법촬영(Illegal shooting) |
| 32 | 전원산업(Jeonwon industry), 정준영(Jeong Jun-young), 관련자(Related people) |
| 33 | 성매매(Prostitution), 외국인 마약사범(Foreign drug criminal), 집중 단속(Intensive crackdown) |
| 34 | 유리 홀딩스 대표(Yuri Holdings representative), 주점 몽키뮤지엄(Monkey Museum), 브랜드 음료 사용료(Using brand beverage) |
| 35 | 한효주(Han Hyo-joo)[[17]](#footnote-17), JM솔루션(JM Solution)[[18]](#footnote-18), 광고모델(Advertising model) |

Test Case Evaluation

In the Table 10, each interval has at least one unique related keyword comparing with adjacent time intervals. From this, it can be inferred that unique keyword represents the new event of that interval. Also, first related keyword can be seen as mostly spotlighted keyword during that period.

However, there are some common keywords between intervals. This is inevitable result since people could be still interested in the past sub-issue along with new sub-issue. In this case both new keywords and old keywords can be on a list. It is also inevitable because this algorithm reorganizes the news articles that are already posted. This means that it’s quite unrealistic to expect time period of news articles to be divided cleanly.

However, it’s very clear that return result (including articles) is more helpful to understand about whole event than normal, scattered news articles. This algorithm at least removes unnecessary common news articles and organizes similar sub-issues which enhances users’ understandability.

2. Case 2

Table 11 is result of algorithm with given input mentioned below. In this test case, exact time period of each interval was added in the return value. Period with most weight (8 chunks) were selected from 2nd to 34th time interval (In Table 10, there are 35 time intervals). First and last time intervals were included without ranking them to make full 10 time intervals of news “sub-issues”. The reason why first and last time intervals were added is to show the starting point (or starting scandal) of issue and to keep the recent “sub-issue” updated.

Table 11. It is result of “Burning Sun” with 10 rephrasing option.

|  |  |  |  |
| --- | --- | --- | --- |
| Time interval | Start – End date | # of days | Keywords |
| 1 | 2019-01-29 ~ 2019-02-04 | 7 | 폭행 사건 (Assault case), 성추행(Sexual harassment), 성폭행(Sexual assault) |
| 2 | 2019-02-12 ~ 2019-02-18 | 7 | 마약 투약(Drug administration), 애나(Anna), 유착 의혹(Suspicion of collusion) |
| 3 | 2019-02-19 ~ 2019-02-25 | 7 | 경찰관(Police officer), 유착 의혹(Suspicion of collusion), 압수수색(Search and seizure) |
| 4 | 2019-02-26 ~ 2019-03-29 | 4 | 성접대(Sexual favor), 이문호 대표(CEO Lee), 사내이사(In-house director) |
| 5 | 2019-03-02 ~ 2019-03-05 | 4 | 이문호 대표(CEO Lee), 유착 의혹(Suspicion of collusion), 마약 투약(Drug administration) |
| 6 | 2019-03-10 ~ 2019-03-15 | 6 | 정준영(Jeong Jun-young), 유착 의혹(Suspicion of collusion), 경찰총장(Police chief) |
| 7 | 2019-03-17 ~ 2019-03-21 | 5 | 김학의(Kim Hak Yi), 구속영장(Arrest warrant), 정준영(Jeong Jun-young) |
| 8 | 2019-03-23 ~ 2019-03-28 | 6 | 린사모(Linsamo), 김학의(Kim Hak Yi), 지창욱(Ji Chang-wook) |
| 9 | 2019-04-17 ~ 2019-04-19 | 3 | 마약 투약 혐의(Suspicion of drug administration), 구속영장(Arrest warrent), 애나(Anna) |
| 10 | 2019-05-09 ~ 2019-05-09 | 1 | 한효주(Han Hyo-joo), JM솔루션(JM Solution), 광고모델(Advertising model) |

Test Case Evaluation

Table 11 is result of using issue “Burning Sun “. Since this algorithm with “option 10” only ranks the time intervals with same issue, relate keywords of time intervals can be also found in Table 10. Third time interval of Table 11 is same with fifth interval of Table 10. All other related keywords of each interval can be found in Table 10 since Table 11 is just rephrasing of Table 10. However, last time interval (most recent sub-issue) is different because test case2 was done on different date and recent news data has changed.

Other than that, effectiveness of result seemed pretty much similar with test case 1. Despite effectiveness of both ways are similar, to compare characteristics between the two (One with option and one without option), One with option is much shorter than one without option so it would save time. However, some issues may be lost because algorithm tried to pick the most spotlighted sub-issues.

At this time, exact period was included in to output. It was obvious that showing exact period of each interval was much better since it shows the length of interval and show exact time point of a sub-issue.

3. Case Discussion

Basic goal of this algorithm is to see the whole story line of given topic. To suit this need, algorithm should detect all the “sub-issues” with periodic units. Also, unit should not be too similar each other because it means it has multiple chunks with same “sub-issue”.

Based on those two cases, this algorithm seems to be partially successful. There were no periods with same top keywords in the result. Although Table11’s 20th and 22nd’s period has same top keyword, we could say that “sub-issue” slightly changed since other two top related keywords differs.

Since result value completely depends on the news data, it’s hard to make clear story line news like chronology. Still, strength of this algorithm is that it can sensitively reflects what people were interested at that period since algorithm uses weight to process(sort) the related keywords. Also even though it doesn’t give timeline news like chronology, it’s definitely helps to understand the whole flow of an event without searching or looking at all the news all along.

Table 12. Title of News at first test case

|  |  |
| --- | --- |
| Time interval | Title of News |
| 1 | 버닝썬 반박 "폭행 사건 인정..마약과 성추행 성폭행은 아냐" (“Burning Sun” reputes “Admits assault case but not sexual harassment and sexual assault”)  ‘승리 클럽' 버닝썬, 디스패치 단톡방 보도에 "물뽕·성추행? 절대 동의 못해" (“Burning Sun”; belongs to Seung Ri, never agrees to usage of “GHB” and sexual harassment) |
| 2 | ‘성관계동영상 촬영 인정’ (Admits illegal sex shooting)  버닝썬 성폭행 논란, 이문호 대표 SNS에 "안심하고 오셔도 됩니다" 글 올려(“Burning Sun”, Dispute on sexual assault, CEO Lee once said the “Burning Sun” is very safe.) |
| 3 | 버닝썬 성관계 동영상` 클럽 직원 참고인 소환(“Burning Sun” sex tape, club’s staff summoned as witness)  ‘버닝썬 성관계 동영상’ 클럽 직원 참고인 소환조사(“Burning Sun” sex tape, club’s staff summoned as witness for investigation) |
| 4 | `버닝썬` 애나, 엑스터시 투약 적발…… 추방 결정 ‘불복’ (“Burning Sun” Anna, injection of ecstasy…… objection to expulsion)  버닝썬 결국 계약 해지...클럽 MD '애나' 엑스터시 투약 의혹 (“Burning Sun” contract terminated…Anna(club MD) suspicion of ecstasy administration) |
| 5 | 경찰 `버닝썬 유착 의혹` 은행계좌·통신 압수수색 (“Burning Sun” alleged collusion with police force. Search for seizure on bank accounts and communication record)  `버닝썬 유착` 계좌·통신 압수수색…… 현직 경찰관 여럿 포함돼 (“Burning Sun collusion” search for seizure on bank account and communication…… had several police officers in service) |
| 6 | “버닝썬 이문호 대표 모발서 마약 양성반응 검출”..경찰, 승리 내사 착수 (Positive reaction on drug on CEO Lee’s hair. Police launch an investigation)  ‘승리 카톡’ 논란에 승리 “자진출두해 마약검사 받겠다”…경찰, 버닝썬 이문호 출국금지 (Seung Ri “hopes to voluntarily appear and get drug test”, CEO Lee forbidden to leave country) |
| 7 | 비에이 영균, 승리 겨냥? 스태프 앞에서 모욕적 언사 "이 정도 해도 안되면…"(Celebrity YoungGyun reveals about SeunRi’s. Personality controversy upon SeungRi)  비에이(Be.A) 영균, 승리 저격?… "비수 꽂더니 몇 배로 돌아가"(Celebrity Be.A posted “What goes around comes around…”) |
| 8 | '버닝썬' 이문호 대표, 10시간 경찰조사 뒤 새벽 귀가…"수사 협조했다" (“Burning Sun” CEO Lee got a police investigation for 10 hours and left at dawn)  버닝썬 이문호 대표, 10시간 경찰 조사받고 귀가 (“Burning Sun” CEO Lee got 10 hours of police investigation and left) |
| 9 | 경찰, 버닝썬 탈세 의혹도 수사…"1년치 장부 분석"(Police investigates on “Burning Sun” tax evasion)  버닝썬 탈세 의혹도 수사 착수…“1년 치 장부 분석 중”(Police investigates on “Burning Sun” tax evasion. Analyzing 1 year of financial record) |
| 10 | 성접대와 탈세, 산더미 의혹에도 군대 간다는 승리…들끓는 여론(SeungRi announce to go to military despite all the controversies around him)  ‘의경 지원’ 논란 승리 “25일 입대할 것”…결국 의경도 불합격(SeungRi applied for police to serve military service but turns out that he failed) |
| 11 | '승리 성접대 의혹' 클럽 아레나 압수수색…승리, 25일 육군 입대 가능할까?(SeungRi suspicion for providing sexual favor. Could he go to military on upcoming 25th?)  승리, '성매매 알선' 혐의 입건(SeungRi Summoned for suspicion of arranging sex favor appointment) |
| 12 | 민갑룡 경찰청장 “버닝썬 유착 의혹? 지위고하 막론 발본색원” (Kap-ryong Min a chief of police hopes eradicate all the suspicious police members related with “Burning Sun”)  승리 카톡방 `경찰총장` 거론된 총경 "정준영 모른다" 참고인 조사 (Chief officer “A” mentioned on Seung Ri’s messenger. Investigation on potential witness) |
| 13 | '버닝썬 미성년자 출입사건' 담당 경찰 피의자로 입건(Minors entered club “Burning Sun”. Policeman charged for backscratching)  '버닝썬 미성년자 출입사건' 담당 경찰, 피의자로…현직 첫 입건(Minor entering club “Burning Sun”. Policeman charged for backscratching for the first time.) |
| 14 | 김부겸·박상기, 문재인 대통령에 '장자연·김학의·버닝썬 사건' 보고 (Boo-kyum Kim and Sang-ki Park, reports about “Burning Sun Gate” to President Moon)  ‘버닝썬 유착’ 의혹 윤 총경 출국 금지 (“Suspicion of collusion” on senior superintendent Yoon. Prohibition of departure on Yoon) |
| 15 | '버닝썬' 경리담장자 돌연 출국 후 잠적(“Burning Sun” accounting manager disappeared after departure)  버닝썬 경리실장, 돌연 해외 출국 후 잠적…경찰 추적 중(“Burningg Sun” accounting manager vanished after departure. Police force tracking him.) |
| 16 | "지창욱 버닝썬 게이트 관련 없어 린사모 사진은 참고용" '그것이 알고싶다' 측 해명 (“Chang-wook Ji is not related to Burning Sun gate” from TV program “그것이 알고싶다”)  '그것이 알고싶다' 측 "지창욱, 버닝썬 린사모와 무관" (TV program “그것이 알고싶다” says Chang-wook Ji is irrelevant with “Burning Sun gate”) |
| 17 | "버닝썬 동영상 잘리기 전에"… 서강대, '버닝썬 농담' 로스쿨 교수들 조사 나서(Professor at law school jokes about “Burning Sun” sex tape)  서강대 로스쿨 교수 "버닝썬 영상 짤리기 전에 봐라" 발언 논란(Seogang Universities law school professor, watch “Burning Sun” sex tape before it’s gone) |
| 18 | 황하나 봐주기 수사 의혹, 경찰 이대로 괜찮나? ‘불신 쌓여’(Suspicion of collusion between police and Hana Hwang)  오늘 국회 정보위 전체회의...김학의·버닝썬 질의 집중될 듯(May be meeting about “Burning Sun” and Hakui Kim at National Assembly Intelligence Committee) |
| 19 | 로이킴도 단톡방에 음란물 유포… 참고인에서 피의자로(Roy Kim arrested for sending illegal obscene material. Witness to suspect)  삼합회까지 연루? 버닝썬 수사 해외로 확장(Is Triad related? “Burnig Sun” investigation expands to overseas) |
| 20 | '정준영 단톡방'→'황하나 마약', 연예계만 떨면 그만?(Scandals about celebrities. Are celebrities sort of victims?)  '승리·정준영 게이트' 이어 '황하나 게이트' 열리나?(“Hana Hwang ”gate right after “SeungRi, Jeongjun Young”gate?) |
| 21 | '버닝썬 유착고리' 전직 경찰, 현직 간부와 중고차 거래(Collusion ties between Burning Sun and police. (Through used car dealing))  '버닝썬 유착' 전직 경찰에게 중고차 산 경찰 입건(Police charged for collusion by used car.) |
| 22 | 로이킴 10일 경찰 출석, 음란물 카톡 유포 혐의 어떤 입장 내놓을까?(Roy Kim suspected for spreading illegal porn. What would he say?)  '정준영 단톡방'엔 무슨 일이 있었던 것일까(What has happened in their chat room?) |
| 23 | 버닝썬 횡령 의혹… 전원산업ㆍ유리홀딩스 압수수색(Suspicion of embezzlement of Burning Sun. Search and seizure on Jeonwon industry and Yuri holdings)  ‘승리 횡령 의혹’ 전원산업 등 2곳 압수수색…‘린사모’ 출석 요청 |
| 24 | 몽키뮤지엄 브랜드 사용료에 버닝썬 자금 수억원… 승리 추가 소환(Monkey Museum seems to have relationship with Burning Sun. SeungRi summoned for investigation)  버닝썬 돈 2억 몽키뮤지엄에 흘러가… 경찰, 횡령 여부 수사(Burning Sun’s 200million won sent to Monkey Museum. Police investigation on embezzlement.) |
| 25 | '버닝썬 마약' 이문호, 구속영장 발부...애나는 영장 기각 (Arrest warrant issued to CEO Lee for “Burning Sun drug case”, rejection of arrest warrant on Anna)  법원, '마약투약' 버닝썬 MD 애나 구속영장 기각…"마약유통 혐의 소명 부족" (Court rejected arrest warrant on Anne for lack of suspicion) |
| 26 | 박진영, 이수만 제치고 연예인 주식부호 1위에 올라(Park; CEO at JYP ent became stock rich among celebrities.)  ‘버닝썬 여파’ 이수만 488억-양현석 322억 주식재산 줄었다(CEO Lee and CEO Yang stock asset diminished because of “Burning Sun” gate’s aftermath) |
| 27 | 버닝썬 직원·정준영·최종훈 등 홍천 여행서 성폭행 정황…피해 여성 "남성들이 준 술 마시고 기억 끊겨"(Burning Sun’s staff and other celebrities suspicion for sexual assault on their trip.)  정준영·최종훈 홍천 여행서도 성폭행 의혹…女 “술 마신 뒤 기억 끊겨”(Junyoung Jeon and JongHoon Choi suspicion for sexual assault on their trip.) |
| 28 | '마약 투약' 버닝썬 이문호 대표 검찰 송치(CEO Lee summon to prosecution for Burning Sun drug administration)  '마약 혐의' 버닝썬 이문호·애나 검찰 송치(CEO Lee and Anna summon to prosecution for Burning Sun drug administration) |
| 29 | "낮에 국가 기여했으니" VVIP 하룻밤 위해 투입된 가출 청소년들(Runway youth put into VVIP’s sexual desire) |
| 30 | 경찰청, 2020년 마약범죄 전담기구 신설 추진(Police agency decided to establish new drug agency by 2020.)  경찰청, 마약조직범죄과 신설 추진…수사인력 대폭 증원(Police agent decided to establish drug agent and reinforcement on investigating force.) |
| 31 | 승리, 금주 내 구속영장 신청될까…경찰 “수사 막바지”(Would SeungRi’s arrest warrant be registered by this week?)  경찰 "`성접대 의혹` 승리 이번 주 구속영장 신청 검토 중"(SurngRi’s arrest warrant under review.) |
| 32 | `버닝썬 MD`, 변호인 선임 지연 이유로 재판 또 연기(Trial suspended because “Burning Sun” MD could not hire lawyer.)  "승리, 이번 주 구속영장"…YG 수사 확대(SeungRi arrest warrant issued by this week. Also planning investigate YG; his entertainment company) |
| 33 | 경찰 집중 마약단속으로 외국인 123명 검거, 중국·동남아 출신 대부분(Police crackdown on drug. 123 people arrested. Most them are from east Asia.)  커피에 과자에…경찰, 마약사범 집중단속 중 외국인 123명 적발(123 foreigners caught for drug administration.) |
| 34 | `버닝썬` 자금 횡령 혐의 승리 피의자 소환(SeungRi summoned as suspect for “Burning Sun” embezzlement)  버닝썬 자금 횡령 혐의, 승리 피의자 신분으로 소환 조사(SeungRi Summoned as suspect for Burning Sun embezzlement.) |
| 35 | 버닝썬 루머 논란에 한효주 측 "33명 네티즌 고소" (Hyo-joo Han charged 33 of Netizens for spreading rumors on “Burning Sun gate”)  한효주, 버닝썬 연관 루머 게시자 고소 (Hyo-joo Han accuses writers about rumors on “Burning Sun gate”) |

Table13. Title of News at second test case

|  |  |
| --- | --- |
| Time interval | Title of News |
| 1 | -버닝썬 반박 "폭행 사건 인정..마약과 성추행 성폭행은 아냐" (“Burning Sun” reputes “Admits assault case but not sexual harassment and sexual assault”)  -‘승리 클럽' 버닝썬, 디스패치 단톡방 보도에 "물뽕·성추행? 절대 동의 못해" (“Burning Sun”; belongs to Seung Ri, never agrees to usage of “GHB” and sexual harassment) |
| 2 | -`버닝썬` 애나, 엑스터시 투약 적발…… 추방 결정 ‘불복’ (“Burning Sun” Anna, injection of ecstasy…… objection to expulsion)  -버닝썬 결국 계약 해지...클럽 MD '애나' 엑스터시 투약 의혹 (“Burning Sun” contract terminated…Anna(club MD) suspicion of ecstasy administration) |
| 3 | -경찰 `버닝썬 유착 의혹` 은행계좌·통신 압수수색 (“Burning Sun” alleged collusion with police force. Search for seizure on bank accounts and communication record)  -`버닝썬 유착` 계좌·통신 압수수색…… 현직 경찰관 여럿 포함돼 (“Burning Sun collusion” search for seizure on bank account and communication…… had several police officers in service) |
| 4 | -“버닝썬 이문호 대표 모발서 마약 양성반응 검출”..경찰, 승리 내사 착수 (Positive reaction on drug on CEO Lee’s hair. Police launch an investigation)  -‘승리 카톡’ 논란에 승리 “자진출두해 마약검사 받겠다”…경찰, 버닝썬 이문호 출국금지 (Seung Ri “hopes to voluntarily appear and get drug test”, CEO Lee forbidden to leave country) |
| 5 | -'버닝썬' 이문호 대표, 10시간 경찰조사 뒤 새벽 귀가…"수사 협조했다" (“Burning Sun” CEO Lee got a police investigation for 10 hours and left at dawn)  -버닝썬 이문호 대표, 10시간 경찰 조사받고 귀가 (“Burning Sun” CEO Lee got 10 hours of police investigation and left) |
| 6 | -민갑룡 경찰청장 “버닝썬 유착 의혹? 지위고하 막론 발본색원” (Kap-ryong Min a chief of police hopes eradicate all the suspicious police members related with “Burning Sun”)  -승리 카톡방 `경찰총장` 거론된 총경 "정준영 모른다" 참고인 조사 (Chief officer “A” mentioned on Seung Ri’s messenger. Investigation on potential witness) |
| 7 | -김부겸·박상기, 문재인 대통령에 '장자연·김학의·버닝썬 사건' 보고 (Boo-kyum Kim and Sang-ki Park, reports about “Burning Sun Gate” to President Moon)  -‘버닝썬 유착’ 의혹 윤 총경 출국 금지 (“Suspicion of collusion” on senior superintendent Yoon. Prohibition of departure on Yoon) |
| 8 | -"지창욱 버닝썬 게이트 관련 없어 린사모 사진은 참고용" '그것이 알고싶다' 측 해명 (“Chang-wook Ji is not related to Burning Sun gate” from TV program “그것이 알고싶다”)  -'그것이 알고싶다' 측 "지창욱, 버닝썬 린사모와 무관" (TV program “그것이 알고싶다” says Chang-wook Ji is irrelevant with “Burning Sun gate”) |
| 9 | -'버닝썬 마약' 이문호, 구속영장 발부...애나는 영장 기각 (Arrest warrant issued to CEO Lee for “Burning Sun drug case”, rejection of arrest warrant on Anna)  -법원, '마약투약' 버닝썬 MD 애나 구속영장 기각…"마약유통 혐의 소명 부족" (Court rejected arrest warrant on Anne for lack of suspicion) |
| 10 | -버닝썬 루머 논란에 한효주 측 "33명 네티즌 고소" (Hyo-joo Han charged 33 of Netizens for spreading rumors on “Burning Sun gate”)  -한효주, 버닝썬 연관 루머 게시자 고소 (Hyo-joo Han accuses writers about rumors on “Burning Sun gate”) |

**Reference**

Eunyoung, Kang 2010, *A Study on the Cases of Applying Interactive Storytelling on the Web Site*, Department of Media Broadcasting Graduate School of Information Sciences 2010.2,

Available at: http://www.riss.kr/search/detail/DetailView.do?p\_mat\_type=be54d9b8bc7cdb09

&control\_no=aadbdcbc32da4d9cffe0bdc3ef48d419#redirect

Haeyeop, Song and Jay, Yang 2017, *Online News Portal Service and changes in News Distribution: Big data Analysis of Naver News in 2010-2017*, Korean Journal of journalism &

Communication Studies 61(4), available at: http://www.dbpia.co.kr/journal/articleDetail=NO

DE07230005

Joan, MacDonald 2019, *How The Burning Sun Scandal Affected Korea’s Drama World*, *Forbes*, Available at: https://www.forbes.com/sites/joanmacdonald/2019/03/15/how-the-burning-sun-scandal-affects-koreas-drama-world/#63dc1dc05b54

Ji-Yeon, Kim and Jae Young, Yun 2015, *A Study on Interactive Stroytelling Methods for Online News*, International Design Conference of KSDS and ADADA with Cumulus, Available at http://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE06634808.

Kyungmo, Kim 2012, *Online News Production in the New Journalism Environment Between Tradition and Change*, Journal of communication research 49(1), Available at: http://www.db

pia.co.kr/journal/articleDetail?nodeId=NODE01793877.

Wi-Geun, Kim 2014, *The Influence of Portal Site News Services on Online Journalism in Korea: The Structural Transformation or the Power Change in the News Distribution*, Korean Journal of Communication & Information (2014.5), Available at: http://www.dbpia.co.kr/

journal/articleDetail?nodeId=NODE02452231.

Yeo-Kwang, Yoon 2014, *A Study on Contents Curation of Portal Sites*, Journal of the Korea Entertainment Industry Association 8(4), Available at: http://www.dbpia.co.kr/journal/article

Detail?nodeId=NODE06069176.

1. CEO at club “Burning Sun” [↑](#footnote-ref-1)
2. MD at club “Burning Sun”. MD is manager at club [↑](#footnote-ref-2)
3. GHB(Gamma- Hydroxybutyric acid). This is drug that cause hallucination. [↑](#footnote-ref-3)
4. Korean Celebrity. Also known as Seung-Ri. He established club “Burning Sun”. [↑](#footnote-ref-4)
5. : Club in Seoul. Also got spotlight as “Burning Sun” scandal arises. [↑](#footnote-ref-5)
6. : Arrested for “Hidden camera” and sharing videos through messenger. Seung-Ri was in that chat room too. [↑](#footnote-ref-6)
7. He was vice minister of Ministry of Justice in South Korea. Accused for providing “Sexual favors”. [↑](#footnote-ref-7)
8. Investor of “Burning Sun” from Taiwan. [↑](#footnote-ref-8)
9. Korean actor. As picture that was taken with Yi-Ju Lin was shown to public, there was suspicion that he was related to “Burning Sun”. [↑](#footnote-ref-9)
10. Korean celebrity. Accused for drug dosage in club “Burning Sun”. [↑](#footnote-ref-10)
11. Korean Celebrity. Establisher of “Burning Sun”. [↑](#footnote-ref-11)
12. One who sued “Burning Sun” for assault. His accusation triggered “Burning Sun” gate. [↑](#footnote-ref-12)
13. Company that invests on cosmetics, real estates or so. Seung-Ri was co-founder. There was suspicion that this company has relationship with “Burning Sun”. [↑](#footnote-ref-13)
14. Company that owns 42% shares of “Burning Sun”. [↑](#footnote-ref-14)
15. Club in Gangnam. This club was managed by Seung-Ri. [↑](#footnote-ref-15)
16. Suicide of Korean celebrity. There was suspicion that cause of suicide was forced “sexual favor” and sexual abuse. [↑](#footnote-ref-16)
17. Korean celebrity. She is model at JM Solution. There was suspicion about drug dosage at club “Burning Sun” party. [↑](#footnote-ref-17)
18. Cosmetic company. JM Solution help party at “Burning Sun”. [↑](#footnote-ref-18)