



Neighborhood Characteristics in Sejong City: Text Mining Analysis of Civil Complaints^{*}

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Abstract

By analyzing related words, the meaning of top keywords can be determined. For example, "installation" was related to safety facilities, such as pedestrian crossings and CCTVs, and "bus" was related to adjusting routes and times and setting up stops. Moreover, "road" was complaints related to vehicle traffic and accidents, and "apartment complex" was complaints regarding the inconvenience caused by noise and illegal parking around an apartment. In addition, due to the real estate in Sejong City, where apartments are the main type of residential buildings, many different complaints about construction companies were registered. The results of the topic modeling analysis were obtained by considering safety, public transport, educational environment, traffic, and parking. Hansol-dong faces problems regarding public transportation, illegal parking, roads, and odor. Goun-dong faced problems with the installation of parks and safety facilities. In Areum-dong complaints and education-related issues were relatively high. While Dodam-dong had parking and accident related problems, and Saerom-dong had relatively high demands for facility installation and complaints regarding accidents. The regional characteristics and vulnerabilities were identified as the main subject in every civil complaint. The lack of public transport, need to set up stops and crosswalks, and maintenance of parks may be temporary problems faced in the beginning by new towns. However, problems such as the lack of parking lots and schools and complaints about odor caused by environmental facilities in some areas may be due to urban planning issues, which require further research.

Keywords Sejong City, Residential Environment, Civil Complaint, Characteristics of Neighborhood, Text Mining
주제어 세종시, 주거환경, 민원, 생활권특성, 텍스트 마이닝

1. Introduction

Planning new towns generally starts with identifying the problems of existing urban areas and then finding ways to address them. This was also the case for Sejong City. In an effort to make it a better city, many experts participated, and

more experimental concepts were attempted, when compared to existing cities (Ahn, K.H., 2015). However, according to the 2015 survey conducted by the Office for Government Policy Coordination on the satisfaction with Sejong City, the group of experts rated it as more than fair, while the group of residents rated it as less than fair (Office for Government

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Policy Coordination, 2016). Understandably, there may be a difference in perspective between the experts who create a residential environment and the citizens who enjoy it. However, if we are to provide people with a better living environment, it is necessary to close this difference (Carmona et al., 2009). This is simply because residential environments, which are governed by urban planning and design, significantly affect the lives of many citizens. Also, citizens serve not only as consumers but also as producers of this urban space, thereby continuing to expand their influence.

Thus far, however, the opinions of residents have not been fairly reflected in the early stage of new town development. Given that the focus of new town development was placed on housing supply, the opinions and perspectives of experts and the government had a greater impact on the planning process. Also, there was another limitation that it was difficult to promote resident participation because no one would reside at the target site from the early planning stage (Kwon, K.D. et al., 2004).

Currently, in Sejong City, citizen participation is actively encouraged. Various citizen-led committees have been established, and their opinions have been reflected in policy making. Citizens are filing their complaints in a more proactive and diverse manner than before. They are not only filing their complaints in writing and on the phone but also posting them on the webpages of various public institutions. In response, the urban development community is striving to find ways to effectively use these data that keep increasing in volume (Nam, K.W. et al., 2014). Analyzing these online complaints will likely serve as a new ex-post evaluation approach.

Continuous research has been conducted on the evaluation of residential environments of new towns. Most of these studies found that the level of resident satisfaction was fairly high (Jang, H.D., 2006; Kim, H.S., 2007; Oh, C.O. and Yang, S.H., 2011; Kim, H.S., 2015; Oh, Y.J. and Yun, K.S., 2016). However, these studies were mostly based on surveys, and the obtained results were considered to have a limitation that it was difficult to determine whether the level of satisfaction they measured had come from the evaluation of the residential environment itself or of the planning factors involved (Hong, K.G., 2013).

The aim of the present study is to analyze the civil complaints made available to the public on the official website of

the Sejong City and thus reveal what the citizens are complaining about and what neighborhood-specific characteristics are found in these complaints. Housing environment-related keywords are examined, which are expected to show what the citizens are actually dissatisfied with, and the feasibility of identifying the spatial characteristics of civil complaints by analyzing online posts will be examined.

II. Theoretical Considerations

1. Text mining analysis

Text mining is an approach where new information is automatically extracted from different written materials using computers (Fan et al., 2006). In technical terms, text mining is a technique that extracts specific keywords or topics from character strings, sorts documents into groups of similar types, and identifies the correlation between the extracted keywords and sorted documents. It is difficult for computers to understand natural language. In this regard, text mining has an advantage that it can convert the written and spoken language of humans, which is unstructured data, into core keywords. This allows users to come up with quantitative values, such as the frequency of each keyword. The recent rapid advances in communications technology and platform and interface applications have been promoting the generation and spread of a large amount of text data throughout the internet space. Furthermore, the government and the business sector have started using this approach, thereby expanding its influence beyond individuals and toward the industry across the board. In doing so, text mining is becoming increasingly important, and the relevant analysis techniques are advancing day by day. In the business management community, a crowdsourcing technique has been introduced as a new approach, in which ordinary citizens attempt to collect opinions to solve a given specific problem. Similarly, in the planning field, there has been a need to introduce a new way of promoting resident participation, like crowdsourcing (Brabham, 2009). In practice, in planning and other policy fields, new ways of satisfaction surveys or public opinion polls are being attempted. This is because conventional surveys, polls, forums, committees, councils, round-table conferences, and discussion sessions are likely to be limited in the number of participants

and the ability to represent the respective target groups. Also, these approaches are implemented less frequently than needed, and thus it is difficult to read ever-changing public opinions in a timely manner (Hwang, M.H., 2014). According to the study conducted by Hong, S.G. et al. (2017), it is now time to implement more intelligent governance built upon cutting-edge technologies, and it will be possible to formulate policies in a more specific and individualized manner by attempting to identify various microscopic needs associated with regional issues on our own, especially through big data analysis applications. The overall new town planning process can also be implemented based on new approaches, such as web-based resident participation or civil complaint analysis techniques using large-scale text data available on the web. In the past, it was difficult to collect opinions from the public, but new approaches are now available, which allow for the analysis of a large volume of documents or complaints on the Internet. Using them, it will be possible to find out what citizens want with regard to new town planning in a more specific manner. These approaches are similar to what is conducted in ethnography, one of the qualitative research methods, but have the advantage that it is also possible to address not only “what” but also “why” questions (Song, K.Y., 2012).

2. Review of previous studies

In domestic academia, research using text mining has continuously been on the rise since 2011 (Kim, S.G. et al., 2016). Good examples are studies related to product reviews and tourist destination reviews. In studies on residential environment and urban space reviews, text mining is mainly used for analyzing resident satisfaction or demand. Park, J.H. and Kang Y.O. (2014) used tweet data to analyze gu-specific resident satisfaction in Seoul and then compared the results with those obtained through surveys. Hwang, M.H. (2014) proposed an unstructured big data-based spatiotemporal analysis model capable of public opinion monitoring as an approach to explore and formulate policies tailored to the target region and demand. Hong, S.G. et al. (2017) proposed several models for reference as a way to settle conflicts arising from the implementation of local public work projects. In an attempt to understand the emotions and attitudes of the persons concerned and citizens, they collected relevant

civil complaint data and posts on different online communities and further performed text mining of them. Park, S.H. and Lee, H.C. (2018) determined that social networking services had a high potential for analyzing the behavior of visitors to markets. In this respect, they collected social networking data related to the two markets of their interest and compared the respective results obtained from the two markets to identify what had caused them to visit those markets. Lee, S.H. and Son, Y.H. (2018) conducted a comprehensive review of blog posts related to the landscapes and actual images of the Taean Coast National Park and different activities available in the place. As a result, perceptions about the park and major relevant issues could be identified. Park, J.S. and Lee, J.S. (2019) analyzed online newspaper articles and demonstrated that the positive sentiment index of those newspaper articles affected the sales price of small apartment houses.

In the meantime, research using text mining to analyze civil complaints is also on the rise. Sung, B.K. and You, Y.Y. (2018) analyzed the civil complaint and policy bulletin boards of the Ministry of Employment and Labor as part of e-People and thereupon identified the major trends of civil complaints and further submitted proposals to improve the relevant schemes and systems. Another study collected and examined environmental complaints and analyzed their spatial patterns (Na, Y.W. et al., 2015) and Kim, H.J. et al. (2018) performed a two-step correlation analysis of posts available on the civil complaint board of Busan City in an attempt to ascertain what the citizens required in a more accurate manner than in previous studies.

The present study applied various analytical techniques used in previous studies to identify the core aspects of the spatial information and civil complaints contained in various posts. However, the present study differed from others in that resident and environmental complaints from new towns, which was rarely the topic of those previous studies, were analyzed, and as a result, their neighborhood-specific characteristics could be identified.

III. Analysis Methods

1. Target research sites

The spatial scope of the present study covers 12 administrative neighborhoods (dong) within the Sejong City. Cur-

rently, this zone is home to 249,788 of residents, which is half the planned number of the population (0.5 million), and the total number of residents in Sejong City amounts to 344,476 (according to Sejong Statistics, as of late November 2019). The total area of Sejong Metropolitan Autonomous City as an administrative district amounts to 464.84 km², and the area of Multifunctional Administrative City, which is currently under development, is 72.91 km². The present study focused mainly on Neighborhoods 1, 2, and 3, where construction had been completed, and most citizens had already moved in Table 1 and Figure 1.

In Sejong City, neighborhood units are uniformly distributed along its annular urban space structure (Ministry of Land, Infrastructure and Transport, 2006). Its center remains empty as an open space, and circular roads for public trans-

portation are designed to connect between its main neighborhoods. The city is a realization of an urban space built on combined concepts of decentralization, uniformity, and democracy (Kwon, Y.S., 2009). Public transportation constitutes a green traffic system that connects pedestrian walkways, bike lanes, and green networks. Also, along the lower part of its residential areas, commercial and community facilities were arranged to build neighborhood streets and thus create a pedestrian-centered environment. At the center of the neighborhoods, complex community centers were built to provide further convenience for the residents. Also, throughout the entire city area, a waste pipeline transportation system was established, and in its proximity, mechanical biological treatment facilities, and combined heat power plants were installed and connected together. This meant that water, waste, and energy were connected and circulated in an organized and mutual manner from an environmental perspective (National Agency for Administrative City Construction, 2006).

Table 1. Site

Area	Name	Area	Name
1-1	Goun-dong	2-2	Saerom-dong
1-2	Areum-dong	2-3	Hansol-dong
1-3	Jongchon-dong	2-4	Naseong-dong
1-4	Dodam-dong	3-1	Daepyeong-dong
1-5	Eojin-dong	3-2	Boram-dong
2-1	Dajeong-dong	3-3	Sodam-dong

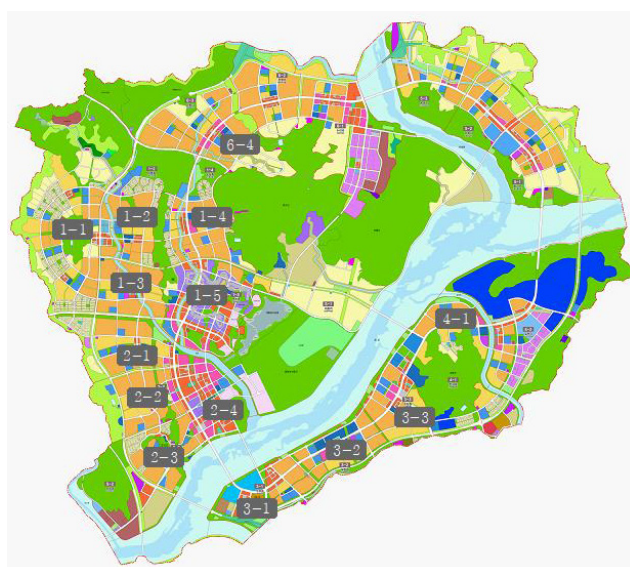


Figure 1. Research area

2. Analyzed materials

In the present study, civil complaints posted on the official website of the Sejong City were collected and analyzed. A total of 7,506 posts were collected from the civil complaint consultation board, which is currently not in service, and the public complaint board under Citizens' Window. From the civil complaint consultation board, a total of 1,907 posts uploaded after the residents started to move into the target areas were collected (those posted from January 03, 2012 - March 29, 2017). A total of 5,599 posts were collected among those made available to the public on the board under Citizens' Window (those posted from May 04, 2015 - December 17, 2019). These two civil complaint boards are places where the citizens can post their civil complaints, suggestions, inquiries, or opinions, and, subsequently, the persons in charge provide answers to them. Citizens must register as members to post content here.

The data collection was conducted on two occasions from May 1 to 3, 2019, and from December 16 to 17, 2019. Posts were automatically collected using a web crawler written in Python. This program is designed to access HTML pages and extract only the necessary parts by using libraries, such as Selenium and BeautifulSoup.

3. Analysis methods

1) Data refinement

Online posts are mainly composed of natural language, which is the language that people typically use in everyday life. Thus, a pretreatment process is required, where documents written in such natural language are disassembled into words. Sentences can be divided into several units, and among them, the most important unit in text mining is a morpheme. In English, these morphemes can be extracted by breaking down sentences based on the spaces or punctuation contained in them. In Korean, however, the extraction of morphemes is more difficult because of endings attached to words, such as postpositions. Morphemes are analyzed using KoNLPY based on the R program. Under this scheme, morphemes are disassembled, and those unrelated to the content of civil complaints are then removed, such as punctuation marks, special character strings, articles, and prepositions. The extracted keywords except stop words are refined using machine learning. For example, ungrammatical words, spelling errors, abbreviations, and slang words are corrected, and similar words are integrated. In doing so, the clarity of data can be enhanced. The integration of similar words is determined by referring to the keywords extracted from planning-stage data, such as Sejong City's development plan reports and district unit plan reports. Those unrelated to urban issues among search keywords, such as "civil complaint," "Sejong," "problem," "necessity," "request," and "measure," were deleted. Also, civil complaints about those other than the target research sites, such as Jochiwon, as well as advertisements and complaints about administrative services, were deleted.

2) Keyword analysis (TF-IDF)

A keyword analysis is performed to find out the main content of civil complaints. A general way of doing this is counting the frequency of each specific word, i.e., how often respective words are used in the entire documents. However, simply counting the occurrence of words may end up with those words that have no special meanings but are repeatedly used across various documents rated as high ranking keywords. Words that are repeatedly used in various documents are highly likely to be those that are used idiomatically rather than those that closely represent the charac-

teristics of each document. Term Frequency–Inverse Document Frequency (TF-IDF) keyword analysis is a method that makes up for this shortcoming. Here, TF refers to the frequency of each term found in documents, and IDF is a value inversely proportional to the number of documents in which each of those specific terms are used. The TF-IDF value is simply the product of the TF and IDF values.

3) Correlation analysis

The content of civil complaints is identified by finding words that have a high correlation coefficient with the words identified as a result of the keyword analysis above. Here, the Term Document Matrix (TDM) is applied, in which different documents are entered in the rows, and the occurrence frequency of words in the same document is presented in the columns. In doing so, it is possible to extract words with high frequency that appear along with each specific word.

4) Topic modeling analysis

The topics of civil complaints are identified through topic modeling. A topic modeling analysis technique is an approach based on the concept that a set of words that repeatedly appear together with one another tend to represent a consistent theme. This approach makes it possible to convert a large number of civil complaint posts into simple expressions.

5) Neighborhood-specific civil complaint analysis

Using the high-ranking keyword analysis, correlation analysis, and topic modeling analysis, major residential environment-related keywords are identified, and the frequency of each keyword in different documents is analyzed to identify which keywords are more frequently mentioned from which neighborhoods. For each major keyword, relevant spatial information, including dong names, village names, and neighborhood names, is identified, separated again, and analyzed. Given that the number of civil complaints differs from one neighborhood to another, the number of civil complaints with regard to each keyword is divided by the number of complaints from the corresponding neighborhoods for correction purposes. This enables us to identify what civil complaints occur noticeably more often in one place than in another. Also, the content of each post is ana-

lyzed to specifically identify what complaints each neighborhood has.

IV. Neighborhood-specific Characteristics of Civil Complaints about the Residential Environment

1. Results of civil complaint keyword analysis

According to the keyword analysis results, the top 50 keywords are as follows in the order of rankings from high to low: “installation,” “bus,” “road,” “apartment complex,” “apartment,” “traffic,” “management,” “safety,” “children,” “Hansol-dong,” “accident,” “commute,” “bus service,” “Daejeon,” “construction,” “Goun-dong,” “route,” “bicycle,” “environment,” “public transport,” “illegal,” “parking,” “regulation,” “signal,” “store,” “bus stop,” “Areum-dong,” “pass,” “garbage,” “facilities,” “school,” “park,” “construction,” “parking lot,” “building,” “Dodam-dong,” “exercise,” “crosswalk,” “cleaning,” “sidewalk,” “walk,” “city bus,” “noise,” “Jongchon-dong,” “smell,” “left turn,” “Saerom-dong,” “taxi,” “lake park,” and “lane” (Table 2). Keywords, such as “installation,” “road,” “apartment complex,” “apartment,” and “safety,” were considered to be related to the infrastructure. The term “installation” was not the direct content of civil complaints about urban planning and had

high redundancy with several keywords, such as “safety,” “signal,” “bus stop,” and “crosswalk.” However, the term was included in the keyword analysis results because it was considered to provide important information, such as what facilities were lacking given the nature of new town planning and what facilities the citizens were demanding. It was also confirmed that there were many complaints related to public transport, as shown by such keywords as “bus,” “traffic,” “commute,” “bus service,” and “route.” Furthermore, six dong were frequently mentioned. They can be listed in the order of frequency of occurrence from high to low, as follows: “Hansol-dong,” “Goun-dong,” “Areum-dong,” “Dodam-dong,” “Jongchon-dong,” and “Saerom-dong.” These were relatively old neighborhoods with many apartment houses.

2. Results of correlation analysis of high-ranking keywords

The top ten keywords were analyzed for their correlation to determine what content each of them would be highly correlated to, as shown in Table 3. The term “installation” was found to have a high correlation coefficient with the following words: in order of correlation from strong to weak, “crosswalk,” “safety,” “camera,” “CCTV,” “walking,” “prevention,” “vehicle,” “speed,” “speed bump,” “apartment

Table 2. Keyword analysis results

Ranking	Keyword (TF-IDF value)	Ranking	Keyword (TF-IDF value)	Ranking	Keyword (TF-IDF value)	Ranking	Keyword (TF-IDF value)	Ranking	Keyword (TF-IDF value)	Ranking	Keyword (TF-IDF value)
1	Installation (1349)	11	Accident (491)	21	Illegal (349)	31	School (269)	41	Walk (223)		
2	Bus (1337)	12	Commute (491)	22	Parking (334)	32	Park (266)	42	City bus (222)		
3	Road (1045)	13	Bus service (471)	23	Regulation (322)	33	Construction (265)	43	Noise (212)		
4	Apartment complex (942)	14	Daejeon (444)	24	Signal (315)	34	Parking lot (253)	44	Jongchon-dong (196)		
5	Apartment (804)	15	Construction (431)	25	Store (310)	35	Building (248)	45	Smell (194)		
6	Traffic (610)	16	Goun-dong (416)	26	A bus stop (310)	36	Dodam-dong (243)	46	Left turn (165)		
7	Management (609)	17	Route (395)	27	Areum-dong (308)	37	Exercise (242)	47	Saerom-dong (163)		
8	Safety (599)	18	Bicycle (370)	28	Pass (281)	38	Crosswalk (242)	48	Taxi (161)		
9	Children (536)	19	Environment (370)	29	Garbage (279)	39	Cleaning (242)	49	Lake park (158)		
10	Hansol-dong (500)	20	Public transport (354)	30	Facilities (271)	40	Sidewalk (240)	50	Lane (140)		

Table 3. Analysis of related words of the top 10 keywords

Ranking	Keyword	Association word (Highest correlation value)
1	Installation	Crosswalk (0.18), Safety (0.17), Camera (0.16), CCTV (0.15), Walking (0.15), Prevention (0.15), Vehicle (0.14), Speed (0.14), Speed bump (0.14), Apartment complex (0.13), Accident (0.12), Road (0.11), Danger (0.11), Traffic (0.11), Cradle (0.11), Signal (0.11), Speed camera (0.11), Bicycle (0.10), Street (0.10)
2	Bus	Route (0.41), Bus stop (0.37), Bus service (0.35), Public transport (0.33), City bus (0.27), Time (0.26), Departure (0.26), Commute (0.25), The interval between buses (0.24), Transfer (0.23), Reorganization (0.21), Transportation (0.21), Boarding (0.21), Arrival (0.20), Via (0.19), Passenger (0.19), Driver (0.19), Stop (0.18), Get off (0.18), Taxi (0.17), Daejeon (0.17), Establish (0.17), Inconvenience (0.16), Adjustment (0.16), Interval (0.16), Increase (0.16), Banseok station (0.16)
3	Road	Vehicle (0.23), Traffic (0.21), Accident (0.18), Construction (0.18), Pavement (0.17), Center (0.16), Bicycle (0.15), Sidewalk (0.15), Approach (0.14), Lane (0.13), Section (0.13), Danger (0.13), Regulation (0.13), Walking (0.13), Signal (0.13), Safety (0.13), Prevention (0.13), Roadway (0.12), Driving (0.12), Construction (0.12)
4	Apartment complex	Installation (0.14), Store (0.13), Crosswalk (0.13), Noise (0.12), Vehicle (0.11), Signal (0.11), Illegal parking (0.10)
5	Apartment	Move in (0.34), Apartment complex (0.23), Lotting-out (0.19), Store (0.16), Households (0.15), Noise (0.14), Surroundings (0.12), Construction (0.12), Construction company (0.12), Flaw (0.11), Noise (0.11)
6	Traffic	Public transportation (0.22), Bus (0.21), Commute (0.19), Vehicle (0.18), Route (0.17), Service (0.17), Signal (0.17), National highway 1 (0.15), Inconvenience (0.14), Time (0.14), Intersection (0.13), Congestion (0.13), Daejeon (0.13)
7	Management	Clean (0.14), Poor (0.13), Facility (0.11), Resident representative (0.11), Weeding (0.11), Park (0.10), Weeds (0.10), Facility management (0.10)
8	Safety	Accident (0.21), Children (0.20), Crosswalk (0.19), Installation (0.17), Danger (0.17), Walking (0.17), Threats (0.17), Child (0.15), Vehicles (0.14), Pedestrians (0.14), Road (0.14), Driving (0.13), Communing (0.13), School (0.12), Speed (0.12), Speed bumps (0.12)
9	Children	School (0.21), Safety (0.20), Kindergarten (0.19), Children (0.18), Mom (0.17), Elementary school (0.16), Daycare center (0.16), Communing (0.15), Parents (0.15), Danger (0.14), Commuting to school (0.14), Safety (0.14), Worry (0.13), Crosswalk (0.13)
10	Hansol-dong	Bus (0.12), Loop bus (0.11), City bus (0.10), Route (0.10), E-Mart (0.10), Handuri bridge (0.10), Terminal (0.10), Hansol middle school (0.09), Cogeneration plant (0.09)

note) Organize words that make sense

complex,” “accident,” “road,” “danger,” “traffic,” “cradle,” “signal,” “speed camera,” “bicycle,” and “street.” These were considered to be related to the civil complaints that demanded the installation of facilities for pedestrian safety.

The term “bus” was found to have a high correlation coefficient with the following words: “route,” “bus stop,” “bus service,” “public transport,” “city bus,” “time,” “departure,” “commute,” “the interval between buses,” “transfer,” “reorganization,” “transportation,” “boarding,” “arrival,” “via,” “passenger,” “driver,” “stop,” “get off,” “taxi,” “Daejeon,” “establish,” “inconvenience,” “adjustment,” “interval,” “increase,” and “Banseok Station.” Complaints related to public transport issues, such as routes, bus stop positions, and service intervals, were identified.

The term “road” was found to have a high correlation coefficient with the following words: “vehicle,” “traffic,”

“accident,” “construction,” “pavement,” “center,” “bicycle,” “sidewalk,” “approach,” “lane,” “section,” “danger,” “regulation,” “walking,” “signal,” “safety,” “prevention,” “roadway,” “driving,” and “construction.” These complaints regarded the safety of vehicles, bicycles, and pedestrians.

The term “apartment complex” was found to have a high correlation coefficient with the following words: “installation,” “store,” “crosswalk,” “noise,” “vehicle,” “signal,” and “illegal parking.” These were considered to be complaints about the pedestrian environment around stores inside the apartment complexes or near the complexes.

The term “apartment” was found to have a high correlation coefficient with the following words: “move in,” “apartment complex,” “lotting-out,” “store,” “households,” “noise,” “surroundings,” “construction,” “construction company,” “flaw,” and “noise.” Many complaints about

defects and construction companies were found. This was considered to be because apartment houses accounted for a large portion of Sejong City’s housing units, and there were many sales of apartment units and residents moving in.

The term “traffic” was found to have a high correlation coefficient with the following words: “public transportation,” “bus,” “commute,” “vehicle,” “route,” “service,” “signal,” “national highway 1,” “inconvenience,” “time,” “intersection,” “congestion,” and “Daejeon.” These were found to be complaints about vehicle driving on National Highway 1 or commuting roads in Daejeon, as well as public transport services.

The term “management” was found to have a high correlation coefficient with the following words: “clean,” “poor,” “facility,” “resident representative,” “weeding,” “park,” “weeds,” and “facility management.” These were complaints related to public space and apartment management.

The term “safety” was found to have a high correlation coefficient with the following words: “accident,” “children,” “crosswalk,” “installation,” “danger,” “walking,” “threats,” “child,” “vehicles,” “pedestrians,” “road,” “driving,” “communing,” “school,” “speed,” and “speed bumps.” These are related to requests to install crosswalks and speed bumps for the safety of children walking along the streets.

The term “children” was found to have a high correlation coefficient with the following words: “school,” “safety,” “kindergarten,” “children,” “mom,” “elementary school,” “daycare center,” “communing,” “parents,” “danger,” “commuting to school,” “safety,” “worry,” and “crosswalk.” These were mainly about the safety of children walking to and from school, similar to the correlation analysis results of

the keyword “safety.”

The term “Hansol-dong” was found to have a high correlation coefficient with the following words: “bus,” “loop bus,” “city bus,” “route,” “E-Mart,” “Handuri Bridge,” “terminal,” “Hansol Middle School,” and “cogeneration plant.” It was deemed that there were many complaints about the public transport system and schools in Hansol-dong and nearby co-generation power plants.

3. Topic modeling results

Topic modeling was conducted to identify the topics of various civil complaint documents, as shown in Table 4. The main topics of civil complaints in Sejong City were found to include safety facilities, public transport, educational environment, road traffic, parking, and environmental issues. Topic 1 (Safety facilities) includes the following keywords: “installation,” “vehicle,” “safety,” “road,” “crosswalk,” “signal,” “walking,” and “children.” These were complaints asking for the expansion of facilities related to pedestrian safety. Topic 2 (Public transport) includes the following keywords: “bus,” “route,” “apartment complex,” “Goun-dong,” “public transport,” “bus service,” “Hansol-dong,” and “change.” It was assumed that there were relatively many complaints about the public transport system in Hansol-dong and Goun-dong. Topic 3 (Education) includes the following keywords: “children,” “school,” “day care center,” “kindergarten,” “education,” “mom,” “commuting,” and “safety.” Similar to Topic 1 (Safety facilities), keywords related to the safety of children walking to and from school were included. Topic 4 (Road traffic) includes the following keywords: “vehicle,” “road,” “signal,” “commute,” “traffic,” “turn left,”

Table 4. Topic modeling analysis results

Topic 1. Safety facilities	Topic 2. Public transport	Topic 3. Education environment	Topic 4. Road traffic	Topic 5. Parking	Topic 6. Environment
Installation	Bus	Children	Vehicle	Parking	Smell
Vehicle	Route	School	Road	Vehicle	Noise
Safety	Apartment complex	Day care center	Signal	Regulation	Apartment complex
Road	Goun-dong	Kindergarten	Commute	Illegal	Apartment
Crosswalk	Public transport	Education	Traffic	Parking lot	Hansol-dong
Signal	Bus service	Mom	Turn left	Road	Bad smell
Walking	Hansol-dong	Commuting	Lane	Store	Nighttime
Children	Change	Safety	Traffic jam	Apartment complex	Environment

“lane,” and “traffic jam.” These were complaints about inconveniences related to road traffic. Topic 5 (Parking) pertains to parking-related issues. It includes “parking,” “vehicle,” “regulation,” “illegal,” “parking lot,” “road,” “store,” and “apartment complex.” These were complaints about the lack of parking space for vehicles and requests for the implementation of parking enforcement on the road and near stores and complexes. Topic 6 (Environment) regards environment-related issues, including the following keywords: “smell,” “noise,” “apartment complex,” “apartment,” “Hansol-dong,” “bad smell,” “nighttime,” and “environment.”

4. Analysis results of neighborhood-specific civil complaints about the residential environment

Lastly, civil complaints about the residential environment of the six neighborhoods, which were among the top 50 keywords, were compared. The analyzed six neighborhoods were Hansol-dong (ranked 10th), Goun-dong (16th), Areum-dong (27th), Dodam-dong (36th), Jongchon-dong (43rd), and Saerom-dong (47th).

All high-ranking keywords were grouped based on similarity into residential environment keywords, as follows: Public transport (search keywords: “bus” and “public transport”), Road (search keyword: “road”), Installation (search keyword: “installation”), Education (search keyword: “school” and “children”), Parking (search keyword: “illegal,” “parking,” and “parking lot”), Accident (search keyword: “accident”), Park (search keyword: “park”), and Bad smell (search keywords: “smell” and “bad smell”). From all civil

complaints, residential environment-related documents were separated, from which all documents that contained spatial information were extracted.

The analysis results showed that the content of civil complaints varied from one neighborhood to another (Table 5). The number of posts that contained those keywords in each neighborhood was divided by the number of posts in the corresponding neighborhood to compare the neighborhood-specific characteristics of civil complaints, as shown in Table 6 and Figure 2. Notably, when there was a unique set of keywords mentioned for a specific neighborhood, the content of the corresponding posts was directly reviewed to find out the cause of the dissatisfaction. For example, a post that contains “bus” and “bus stop” as keywords may differ from one that contains “park,” “bus,” and “bus stop” in terms of content. In general, there were many complaints asking for the installation of bus stops, but in some neighborhoods, the installation of bus stops was requested because it was difficult to access a park by public transport. For that reason, the content of individual complaints specific to each neighborhood was thoroughly examined before they were classified.

In the case of Hansol-dong, the number of civil complaints was relatively high. When compared to the other neighborhoods, matters related to public transport, parking, road traffic, and bad smell were more frequently mentioned. When it comes to public transport, there were 98 posts regarding route issues, 80 posts regarding the installation of bus stops, and 53 posts regarding service intervals. With regard to parking, the number of posts asking for the implementation of parking enforcement was the largest at 52. Also, there were 35 complaints about the lack of parking

Table 5. Frequency analysis of complaints by neighborhood

Parameter	Public transport	Road	Installation	Education	Parking	Accident	Park	Bad smell
Hansol-dong	233	171	113	102	116	56	44	50
Goun-dong	163	121	143	91	58	41	89	31
Areum-dong	99	79	74	80	47	24	33	9
Dodam-dong	116	84	68	56	63	41	17	8
Jongchon-dong	97	68	60	55	38	16	32	10
Saerom-dong	70	50	64	43	35	24	18	5
6 neighborhoods complaints	778	573	522	427	357	202	233	113
Total complaints	1,565	1,548	1,361	1,055	914	703	571	288

Table 6. Comparison of neighborhood by residential environment complaints

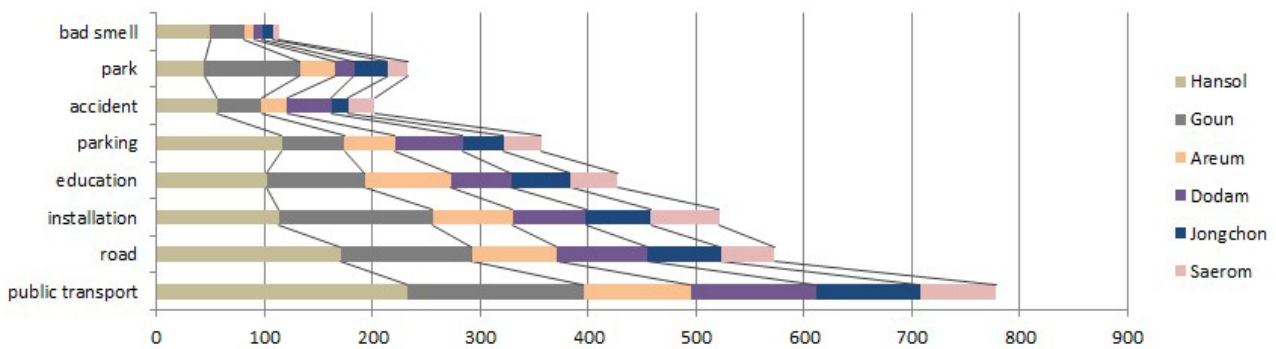
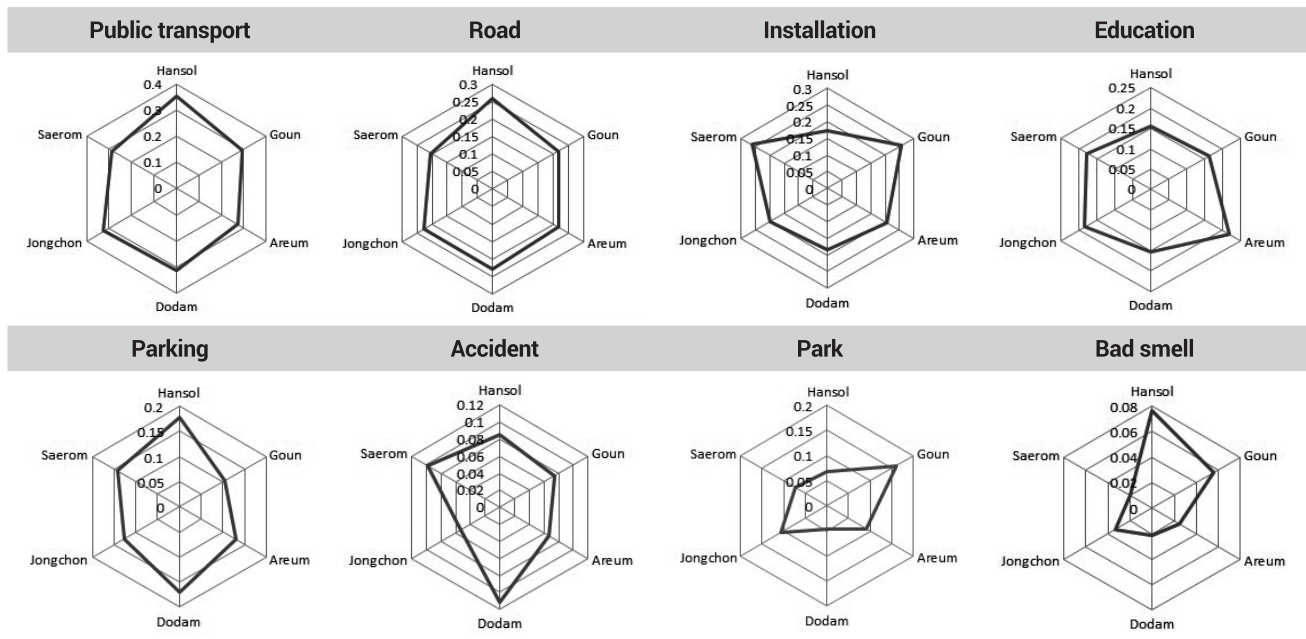


Figure 2. Frequency analysis of residential environment complaints by neighborhood

space and facilities. Issues related to illegal parking near the shopping area were frequently raised (31 posts). Among complaints related to road traffic as well, parking problems were most frequently mentioned (41 posts). There were also 15 posts requesting the installation of facilities that help improve the pedestrian environment, such as crosswalks. With regard to complaints related to bad smells, there were 13 posts that said that it smelled even worse during certain seasons and time of day, for example, in summer evenings. There were eight complaints that pointed to burnt smell and illegal incineration from co-generation power plants and another eight complaints about bad smell from nearby restaurants, laundries, and outdoor units of air-conditioners along the roadside. Also, there were eight complaints about garbage smell and another eight complaints about smells coming from barns.

In the case of Goun-dong, the number of complaints about facility installation and parks was relatively high. With regard to facility installation, the number of complaints asking for the installation of facilities inside parks, including Gountteul Park, was the highest at 143. Furthermore, there were 29 posts asking for the installation of bus stops and new routes, 20 posts asking for the installation of crosswalks, and 16 posts asking for the implementation of the bike-sharing system. With regard to parks, there were 39 requests for the maintenance of trails, decks, and lighting facilities in Gountteul Park. Also, there were 19 complaints about the lack of public transport to parks, 15 posts requesting the installation of safety facilities near parks, such as crosswalks, and 14 complaints against the installation of pet dog playgrounds. In the case of Goun-dong, complaints related to Gountteul Park were most frequent.

In Areum-dong, there were many complaints related to education. More specifically, those who failed to enroll in nearby elementary and middle schools because they were overpopulated were forced to commute to and from more distant schools, but the lack of public transport added to their inconvenience. There were 18 posts regarding these problems. There were 14 complaints about the safety of school walkways where illegal parking and speeding were common, and crosswalks were not well prepared. Also, there were six posts asking for the installation of pedestrian decks and tunnels and four requests that sports facilities be made available to the citizens at all times because there was a lack of space for children's athletic activities, such as swimming pools and sports facilities.

In Dodam-dong, there were many complaints about parking and accidents. It was found that illegal parking was frequently, especially in the shopping district of Dodam-dong (17 posts). There were 27 posts asking for the implementation of parking enforcement and 37 posts complaining about the lack of parking space and poor status of parking lot entrances, as well as asking for making public parking lots available to use.

In Saerom-dong, there were many complaints about facility installation and accidents. There were many posts requesting the installation of bus stops and public transport-related facilities (18 posts). In addition, there were 14 complaints about pedestrian facilities, such as crosswalks, pedestrian overpasses, and lighting facilities; nine posts asking for the installation of bicycle rental facilities; five complaints about CCTV installation; another five complaints about the installation of sports facilities, such as swimming pools and basketball courts; and four requests for the maintenance of speed bumps. With regard to accidents, there were nine complaints about the risk of accidents due to illegal parking, placards, occupied sidewalks, and construction works; five complaints about the risk of pedestrian accidents due to motorcycle messengers' reckless driving; and five complaints about the failure of the signal system and traffic lights and the danger associated with roundabouts. Among the six neighborhoods, this one was most recently developed, and thus understandably, there were more complaints requesting the adjustment of public facilities, such as bus stops and crosswalks.

As can be seen in the neighborhood-specific analysis

results, civil complaints about the residential environment varied from one neighborhood to another. Hansol-dong faced many complaints about public transport, parking, road traffic, and bad smell, while in Goun-dong, there were many complaints about Gountteul Park. Areum-dong received many complaints about students' commute to and from school, while Areum-dong faced many complaints about parking and the risk of accidents near the shopping district. In Saerom-dong, there were relatively many complaints asking for the installation of safety-related facilities while demanding measures to prevent accidents.

V. Conclusions and Policy Implications

In the present study, civil complaints from Sejong City were analyzed to determine what urban and environmental problems were most frequently mentioned by its citizens. Also, the content of civil complaints was reviewed to see if there would be a difference in civil complaint patterns among different neighborhoods. In doing so, the potential for identifying the neighborhood-specific characteristics of civil complaints was assessed.

The overall frequency analysis of civil complaints showed that terms related to the infrastructure, such as installation, roads, and crosswalks, were noticeably frequent. Also, such keywords as safety and children were found to rank high. This implied that there were high demands for the installation of pedestrian safety facilities.

Topic analysis results showed that the main topics of civil complaints included safety facilities, public transport, educational environment, road traffic, parking, and environmental issues (bad smell). Here, requests for safety facilities and complaints about public transport and educational environments may be understood as resulting from the lack of infrastructure, which is commonly seen in new towns at the early stage of development. Despite them being new towns, however, parking issues are still raised, and odor problems are among the main topics of civil complaints. Note that those problems have been issues of concern to existing, well-established towns. Accordingly, it is necessary to check whether these issues have been caused by certain problems associated with urban planning. Meanwhile, those complaints about the installation of safety facilities and educational environments also include safety issues regarding the

pedestrian environment. Thus, it is also necessary to review the overall pedestrian environment. Parking and environmental issues (odor) and pedestrian safety were more frequently mentioned in certain neighborhoods.

Also, it was worth noting that the characteristics of civil complaints differed from one neighborhood to another. In some neighborhoods, there were many complaints about public transport, parking, and road traffic, while in others, there were more complaints about schools, parks, and safety. Notably, the fact that many complaints regarded public transport and roads in some neighborhoods where complaints were large in number clearly indicates that there is much to contemplate going forward with regard to Sejong City itself, which has been explicitly pursuing to be a public transport-centered city.

Based on these research results, policy implications may be proposed, as follows.

First, it is necessary to determine whether the content of these civil complaints constitutes a temporary problem or a problem arising from the planning stage. For example, the lack of public transport may be a temporary phenomenon faced by most new towns at the early stage of development. However, road systems, lack of parking space, and odor problems caused by environmental facilities near the residential areas need to be separately examined to see whether any problems associated with urban planning are involved.

Second, it is necessary to determine whether there are any structural problems in the neighborhoods with more numbers of civil complaints, such as Hansol-dong, Goun-dong, and Areum-dong. For example, there were many complaints about roads and public transport in Hansol-dong and Goun-dong. Now, it is important to find out whether this dissatisfaction came from a failure to properly operate public transport services or from poor accessibility to the public transport resulting from the initial road planning.

The limitations of this research are as follows: It was impossible to collect civil complaints that were not made public, and thus only the data made available to the public were collected and analyzed. Also, there is no guarantee that civil complaints can represent the overall opinions of every person in an accurate manner. In addition, the degree of satisfaction is an emotional state that can be influenced by the internal and external factors of individuals (Locke, 1967). Furthermore, the subjects of urban planning, which were

previously recognized by the citizens, are part of the public service sector. In the public service sector, unlike in the private sector, the degree of satisfaction has to be affected by various external factors, such as taxes, crimes, and real estate prices (Manzi and Saibene, 2017). Another point is that in the present study, a keyword analysis technique was applied as the key research methodology. Under this approach, even the same word can be used in a different way in different sentences, and thus there was a limitation in accurately identifying the content of complaints. Therefore, even the same words were used, it was necessary to examine and confirm the specific details of individual complaints.

Nevertheless, the significance of the present study lies in the fact that it was possible to gather the *Voice of Customer* for a government-led project. Kim, C.D. and Lee, J.Y. (2014) insisted that it would become more important going forward to look into the response of customers to administrative services through resident participation. In the present study, urban environments were evaluated using a new approach based on civil complaint analysis. Thus far, urban planning has been the domain for experts only. Planning itself requires expertise and can possibly lead to corruption because the process is directly connected to interests. However, modern urban planning keeps evolving in nature over time while involving various stakeholders, thereby adding to the complexity. Accordingly, a cooperative and communicative approach has become an integral part of urban planning today (Healey, 2003).

Thus, if one can identify what complaints are causing the most inconvenience to citizens among all civil complaints made public by using unstructured data and further present them in a way that is easy to understand, this will help people find out what the real problems are so that they can refer to these results in policy decision making. Notably, this approach will enable to identify urban environmental problems in a spatial manner. Also, if these civil complaint analysis results are presented in an easy-to-understand manner, citizens will be able to refer to them and further engage in discussions on general urban issues from a wider perspective. Understandably, those who attempt to file their complaints must think that their own complaints are the most pressing and urgent. However, if one can clearly summarize the overall content of civil complaints, pending issues, and the corresponding countermeasures and inform them of the results,

it will be possible for them to engage in discussions from a more public point of view. Also, the transparency of administrative decision making can be improved by summarizing and making public resident complaints about urban environments and planning.

Future study should focus not only on civil complaint data from Sejong City Hall but also on various data available on social network services and online communities so that a wider range of opinions can be examined. In the present study, a keyword analysis technique was mainly used to identify the content of civil complaints, but it will also be possible to use various other methods, including sentiment analysis. Also, further research is needed to examine the overall plan under which Sejong City has been established and analyze what has caused those civil complaints.

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