



## Understanding Food Waste in Bulk in Incheon: Based on Naver Blog Big Data

Junsuk Choi<sup>a</sup>, Joonhyeong Joseph Kim<sup>b†</sup>, Sang Mook Lee<sup>c</sup>

<sup>a</sup>Department of Hotel & Restaurant Management, Cheju Halla University, 38, Halladaehak-ro, Jeju-si, Jeju-do, Republic of Korea

<sup>b</sup>Department of Hotel Management, Cheju Halla University, 38, Halladaehak-ro, Jeju-si, Jeju-do, Republic of Korea

<sup>c</sup>Department of Tourism Management Jeju National University Jeju-do, Republic of Korea

### ABSTRACT

**Purpose:** This study aims to provide insight into the contemporary food waste issue for the better management of food waste in large quantities in Incheon, one specific region in Korea, based on the analysis of the Naver Blog corpus, employing analysis techniques including text mining and LDA topic modeling.

**Design/methodology/approach:** In order to achieve the aforementioned objectives, the current study has employed the R program for the analysis (e.g., TF, tf-idf, correlation, and LDA) of 868 Naver Blog posts which included information about food waste, and/or garbage produced in bulk by foodservice operators in the context of Incheon.

**Findings:** The frequently addressed keywords in the dataset include food, waste, garbage, processor, workplace, food waste dewaterer, microorganism, pulverizer, plastic, compressor, restaurant, sink, cafeteria, and bean sprouts. The correlation analysis demonstrated that waste is largely generated by food material, and food material is closely related to specific types of private companies (e.g., cafeterias) and public places (e.g., military bases, prisons, hospitals). The LDA identified three topics: the implications for food waste produced by the workplace, recent equipment and technologies used for food waste processing, and effect of waste on the environment and call for remedies.

**Research limitations/implications:** While this study has shed light on contemporary issues in relation to food waste in Incheon, it is suggested that the involved parties in the waste management industry pay more attention to the development of effective waste management strategies by hospitality operators in a specific region.

**Originality/value:** This study responds to a lack of understanding underpinning foodservice operators who produce a large quantity of food waste in Incheon, albeit much attention has been paid to some recent research on food waste.

*Keywords: Food waste, Text mining, Correlation analysis, Topic model, LDA*

## I. Introduction

While tourism and hospitality marketing literature have attempted to understand how to maximize customers' consumption through the relationship

between customers and brand which may lead to loyalty (X. Chen, Hyun, & Lee, 2022; X. Chen & Lee, 2021; X. Chen, Lee, & Hyun, 2022; J. Y. Lee & Jin, 2019; Praesri, Meekun, Lee, & Hyun, 2022), there is an imminent need for a paradigm shift towards sustainable goals such as minimizing food waste (e.g., Jeon, 2023). Literature on food waste points out that a large amount of food waste has, arguably, been attributable to so-called wasteful hospitality operations,

Received: Nov. 9, 2023; Revised: Dec. 2, 2023; Accepted: Dec. 18, 2023

† Corresponding author: Joonhyeong Joseph Kim

E-mail: [josephkim@chu.ac.kr](mailto:josephkim@chu.ac.kr)

placing negative impacts on the environment (Juvan, Grün, & Dolnicar, 2023). However, while research on hospitality food waste in the restaurant sector has provided implications for restaurants, hotels, education establishments and prisons, there has been no sufficient understanding of food service settings as a whole. Prior studies on hospitality food waste include waste programs in hotels, food waste in UK coffeeshops, and factors influencing the reduction in food waste. Filimonau and De Coteau (2019) conducted the critical analysis of the literature on the issue of hospitality food waste and presented the understanding of factors influencing hospitality food waste mitigation. Talwar, Kaur, Okumus, Ahmed, and Dhir (2021) have provided an understanding of diners' behavior toward generating and mitigating food waste. Juvan et al. (2023) have found a high proportion of biodegradable kitchen and canteen waste generated within an average hotel or restaurant business. Additionally, prior studies highlighted that in general, high-income nations and developed countries have received a relatively higher level of academic attention from researchers, with a call for research on food waste in developing countries.

Furthermore, with a global initiative on the circular economy and reduction in food waste, there has been some media interest around the globe due to a significantly increased rate of food waste recycling in Korea. In contrast with the situations in the EU and the UK, the rate of recycling of food waste has increased from 2.6% to almost 100% in Korea (Kim, 2022). In fact, the change in the figure is remarkable given that it is known that the US is still not recycling most of its food waste, which is rather disposed of in landfills. In relation to waste management policies, the Korean government has issued the Waste Control Act to promote general guidelines for the management of waste generated on a national scale. Recent waste management strategies are hinged on resource circulation building on the notion of the circular economy. The Waste Control Act prescribes the regulation of plans to restrain the generation of food waste and persons discharging food waste. Despite the interest in the circular economy and resource

circulation with its application to food waste management, there is no single study which provides specific understanding of what issues are available with regard to the issue of food waste in a local city in Korea. The purpose of the current study is to provide insight into the contemporary food waste issue for the better management of food waste in large quantities in Incheon, one specific region in Korea, based on the analysis of the Naver Blog corpus, employing analysis techniques including text mining and LDA topic modeling.

## II. Theoretical Background

### A. Research on Food Waste

While Cerciello, Agovino, and Garofalo (2019, p. 1141) referred to food waste as "*any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed*", its negative influence, such as a large amount of economic, environmental and societal costs, is well documented in the Food and Agriculture Organization of the United Nations' (FAO) report published in 2014. As a result, there have been a series of efforts to cope with issues related to food waste from the perspective of two major parties who are likely to influence food waste, including managers/chefs and clients. Prior research on food waste has investigated various factors influencing food waste intention from the viewpoints of customers and managers, including chefs' attitudes toward food waste mitigation initiatives (e.g., Shao, Jeong, Jang, & Xu, 2020; Teng, Wang, & Chuang, 2022). Importantly, while several studies have highlighted that one of the approaches to food waste is to identify areas for food loss and/or leftovers and strategies for reducing food waste (Betz, Buchli, Göbel, & Müller, 2015; Talwar et al., 2021; Vizzoto, Testa, & Iraldo, 2021), a managerial perception of possible benefits of reduced food waste (e.g., attitude toward contribution to cost reduction) has played an important role in participating in relevant practices of reducing food

waste (Ludovica Principato, Pratesi, and Secondi, 2018). Similarly, while it was argued that food waste comes from suppliers, manufactures, retailers, food service, and consumers along the food supply chain, Ciccullo, Fabbri, Abdelkafi, and Pero (2022) explored the manufacturer and retailer stages in the downstream supply chain and found that companies were more likely to create value by adopting a better way of managing food waste, rather than closing the loop in the agri-food supply chain. Furthermore, it was found that food waste in the retail sector could benefit from the application of a dynamic pricing model leading to reduced food waste through the intervention of a sales boost (e.g., Kayikci, Demir, Mangla, Subramanian, & Koc, 2022). In contrast, customers have also been responsible for the reduced production of food waste (Ludovica Principato et al., 2018; Shao et al., 2020), whereas effective ways of communication are found to be conducive to customers' participation in food waste reduction efforts (Shao et al., 2020). Prior studies demonstrated that a larger amount of waste is generated by clients in comparison with that coming from the kitchen. This highlights a need for customers to change their behavior (Eriksson, Persson Osowski, Malefors, Björkman, & Eriksson, 2017; Ludovica Principato et al., 2018). However, the literature suggested that persuading customers to accept the food waste message is not such a simple task. While Shao et al. (2020) found that customers were found to be more persuaded to purchase ugly food when faced with advertisements in anthropomorphic terms, one recent study has highlighted that more attention needs to be paid to the influence of the level of mindfulness when a verbal message about food waste reduction efforts is presented before meals (Olavarria-Key, Ding, Legendre, & Min, 2021).

Researchers have argued that research on food waste is limited, especially in the context of geographic scope (Filimonau, Krivcova, & Pettit, 2019; L. Wang et al., 2018). L. Wang et al. (2018) have noted that the understanding of food waste in developing countries is limited. Specifically, while food waste research has been conducted largely in the context of developed countries, the study by L.

Wang et al. (2018) highlighted that food waste in Lhasa, Tibet, in western China has almost reached that of developed countries. Recently, numerous researchers have highlighted the usefulness of using big data to better understand given phenomena such as food waste (e.g., Ciccullo et al., 2022; Kayikci et al., 2022). Several studies have paid attention to an important role of big data predictive analytics which helps to mitigate deteriorated food and vegetables and to enhance competitive advantage, environmental and economic performance in the food waste and recycling industry (de Souza et al., 2021; Nilashi et al., 2023).

## **B. Application of Circular Economy to Management of Food Waste in Incheon**

The rationale for selecting Incheon as the studying context is based on a tentative premise that Incheon has been one of the leading local governments in Korea in terms of waste reduction as suggested by 'comprehensive plan for reducing waste' (Kim, 2020)." In fact, Incheon has attempted to apply resource circulation building on circular economy to its waste management policy in line with the recent green approach toward a zero-waste society (e.g., Yang, Park, Park, & Seo, 2015). Filimonau et al. (2019) emphasized the role of focused policy intervention for effectively managing food waste among the associated businesses related to UK coffeeshops, as governmental support and properly implemented legislation are conducive to management's enhanced approaches to waste management. The government of the Republic of Korea has issued a Framework Act on Resources Circulation, which attempts to promote a formulation and implementation of action plans for waste reduction building on resource circulation in the jurisdiction of the Metropolitan City, given the governmental shift from waste treatment to resource circulation (Yang et al., 2015). As part of waste management from the perspective of resource circulation, Incheon has been collecting data in relation to the business entity of producing food waste in

large quantities. Incheon is one of the six Metropolitan cities located in the northwestern area, approximately 30 kilometers west of the capital city of Seoul in the Republic of Korea. Whereas a vast number of general restaurant businesses and facilities providing meals were registered in this city, there are other types of foodservice operators including rest restaurant businesses, tourist accommodation businesses, superstores, and tourist facility businesses. It has been noted that while the process of treating food waste is known as one of the causes of climate change, particularly the emission of greenhouse gases (GHGs), the establishment of a sustainable circular bioeconomy was argued to play an important role in responding to the associated issues of food waste (Mak, Xiong, Tsang, Yu, & Poon, 2020). S. Lee, Park, and Ahn (2020) have shown that there have been fourteen recycling companies for food waste in Incheon, the byproduct of which was known to be animal feed and compost in many cases.

However, there has been limited understanding of the issue of food waste based on big data in order to avoid the aforementioned limitations inherent in prior research on food waste despite the growing attention to the circular economy and waste management. While prior food waste research has been conducted using qualitative and quantitative, and sometimes via mixed methods, it was prone to several research design weaknesses such as the problem of inaccurate responses collected through self-reports, and interviews on food waste research, often employing a small sample size, according to Dhir, Talwar, Kaur, & Malibari (2020). However, given food waste in Incheon has not received much attention in the literature, this study's objective is to contribute to addressing this research gap especially in terms of understanding contemporary food waste issues by employing big data.

### III. Methods

While numerous researchers from other countries

collected from micro-blog sites such as Sina and Twitter (Gu, Zhang, Chen, & Chang, 2016; Mao, Niu, Chen, Wang, & Atiquzzaman, 2018), this study collected and processed textual data from Naver Blog. Naver is one of the most famous and powerful internet search engines in Korea, and was founded in 1999 and the popular source of collecting big data (Cho, 2021; Go et al., 2020; Han & An, 2022), whereas Naver Blog is a dynamic online community, where real-time information is provided on a given topic (e.g., food waste). This study carried out word frequency, wordcloud and correlation analysis between keywords, followed by topic modeling analysis employing LDA (Latent Dirichlet Allocation). R-package 4.1.2 was used for data collection, pre-processing and analysis. As the current study aims to uncover recent trends in a large amount of text and to identify keywords and themes in collected documents, the method adopted for the current study improves the past food waste studies' weaknesses such as inaccurate responses and small sample size, as argued by Dhir et al. (2020). Naver portal has received recent attention from numerous researchers as a popular source of collecting big data due to its volume and diversity of data (e.g., Jang & Park, 2020).

#### A. Food Waste Data Collection and Pre-Processing

This study has developed food waste data that describes food waste-related issues in the context of Incheon Metropolitan City based on the collection of a large amount of unstructured text. Naver Blog was chosen as the source of data given that Naver is considered to be one of the biggest portal sites, which not only provides information about topics such as the weather, general knowledge, and real estate, but also serves as a social networking site through Naver Blog, which is known to be used by 58% of Koreans (Naver, 2021). In fact, the given administrative authorities have been auditing the practices of workplaces which produces waste in large quantities. Thus, in order to focus on Naver Blog

posts related to food waste produced by business workplace based in Incheon, search terms included Incheon Metropolitan City, Waste, and workplace with produces in large quantities. Having searched for the text related to foodservice operators who produce food waste in large quantities, the process of collecting food waste data in the current study was completed by R Studio (2021.09.2+382), an integrated development environment for R. Of 2953 documents collected from Naver Blogs, 868 blog posts were used for further analysis after removing repetitive content and the aforementioned irrelevant content.

This study used `r_parser_r` function in `NLP4kec` package to break the sentences down into parts and underwent the steps of converting the data into a corpus, followed by the removal of less meaningful information such as symbols, numbers and English characters, and breaking down the textual data into words, which is called a process of 'tokenization', and word stemming. In order to understand the basic characteristics of the corpus, keyword frequencies (TF), TF-IDF (term frequency-inverse document frequency) along with a wordcloud of the top keywords were presented. Additionally, correlation results between chosen keywords were conducted.

## B. Topic Analysis Based on LDA

Topic models refer to unsupervised methods, which automatically process, understand, search and summarize a large amount of unstructured data in the textual format (Blei, Ng, Jordan, & Lafferty, 2003). LDA extracts a range of terms which tend to appear together. In this way, LDA identifies latent topics characterized by discrete probability of words within these topics (Qiao, Shan, Zhang, & Wei, 2022). The current study aimed to extract key topics based on LDA modeling to highlight issues underpinning waste management. According to Blei et al. (2003), LDA assumes three generative processes for each content in a corpus, D.

- 1) Choose  $N \sim \text{Poisson}(\delta)$
- 2) Choose  $\theta \sim \text{Dir}(\alpha)$
- 3) For each of the  $N$  words  $w_n; (\theta)$ 
  - (1) Choose a topic  $z_n$  Multinomial
  - (2) Choose a word  $w_n$  from  $p(w_n|z_n, \beta)$ , a multinomial probability conditioned on the topic  $z_n$

The aforementioned Steps 1 and 2 illustrate that the length of the blog contents ( $N$ ) is in line with the Poisson distribution, while the probability of topics may be obtained through Dirichlet random variable  $\theta$  with  $k$  dimension, which can be known through the probability density function in the equation (1) as follows:

$$p(\theta | \alpha) = \frac{\Gamma(\sum_{i=1}^k \alpha_i)}{\prod_{i=1}^k \Gamma(\alpha_i)} \prod_{i=1}^k \theta_i^{\alpha_i - 1} \quad (1)$$

Word probabilities of each topic are based on a set of vectors consisting of  $\{w_1, w_2, \dots, w_n\}$ . Having understood the topic mixture ( $\theta_1, \theta_2, \dots, \theta_v$ ), in Step 3,  $\beta$ , a generative probability of words corresponding to topics, refers to a  $k$ -dimensional dirichlet random variable in relation to a chosen topic. A simultaneous distribution of a topic mixture  $\theta$ ,  $N$  topic index  $z$  and  $N$  words  $w$  can be given in equation (2).

$$p(\theta, z, w | \alpha, \beta) = p(\theta | \alpha) \prod_{n=1}^N p(z_n | \theta) p(w_n | z_n, \beta) \quad (2)$$

The following equation (3) calculates the marginal distribution of a document by considering the topic mixture  $\theta$  and summing over topic index  $z$ , which gives a glimpse of the probability of words  $w$  in the blog content given  $\alpha$  and  $\beta$ .

$$p(w | \alpha, \beta) = \int p(\theta | \alpha) \left( \prod_{n=1}^N \sum_{z_n} p(z_n | \theta) p(w_n | z_n, \beta) \right) d\theta \quad (3)$$

The probability of a corpus  $D$  is obtained through

involving the product over all the documents, as shown in equation (4).

$$p(D | \alpha, \beta) = \prod_{d=1}^M \int p(\theta_d | \alpha) \left( \prod_{n=1}^{N_d} \sum_{z_{d_n}} p(z_{d_n} | \theta_d) p(w_{d_n} | z_{d_n}, \beta) \right) d\theta_d \quad (4)$$

## IV. Results

### A. Keyword Frequency and Wordcloud

As shown in Table 1 and Figure 1, the most frequently appearing terms apart from food, waste and garbage include processor, workplace, food waste dewaterer, microorganism, pulverizer, plastic, compressor, restaurant, sink, cafeteria, and bean sprouts, with much attention being paid to food waste management in general, location-related keywords, methods of managing waste and garbage. There have been terms related to a range of systems for food waste management (e.g., pay-as-you-go waste disposal system). There is some implication for the environment in the following keywords: energy, Ministry of Environment and greenhouse gas. The issue of treating (food) waste is associated with many different places such as Gyeonggi-do, and

Gyeyang-gu within the jurisdiction of Incheon.

Previous studies have argued the usefulness of recognizing a range of meaningful terms by comparing TF and tf-idf analyses. While keyword frequency has only been limited to terms of nouns, several important parts of speech in English, TF and tf-idf include nouns, verbs and adjectives. As for TF, food material, waste, garbage, processor and workplace appeared on the highest ranks of keyword term frequencies. On the contrary, food material, processor, rental, waste, Hayeon, Food waste dewaterer, container, installation, and pulverizer received more attention in terms of TF-IDF, as shown in Table 2. Hayeon, one of the significant words appearing in terms of tf-idf, is known as a manufacturer of food waste machines (Hayeon, n.d.), while Cleame is another company famous for its food waste machines that are able to process food waste containing microorganism.

### B. Correlation

The food waste data shows that food material plays an important role in explaining the phenomenon behind food waste related to Incheon. The current study extracted the top ten terms with the highest correlation with food material. The correlation matrix

**Table 1.** Keyword frequency

Ranking	Keyword	Frequency	Ranking	Keyword	Frequency
1	Food	11881	14	Bean sprouts	690
2	Waste	10048	15	Energy	624
3	Garbage	8104	16	Bulk	612
4	Processor	5902	17	System	590
5	Workplace	2551	18	A range of food items	584
6	Food waste dewaterer	1435	19	Gyeonggi-do	565
7	Microorganism	1240	20	Ministry of Environment	548
8	Pulverizer	965	21	Disposable	533
9	Plastic	908	22	Gyeyang-gu	531
10	Compressor	867	23	Pay-as-you-go waste disposal system	516
11	Restaurant	769	24	Public Procurement Service	460
12	Sink	695	25	Greenhouse gas	450
13	Cafeteria	693			

shows some high correlations between food material and processor (0.89), military bases (0.69), public procurement service (0.66), prison (0.66), cafeteria (0.65), leftover (0.64), marketplace (0.63), hospital (0.62), and superior (0.61), as shown in Figure 2.



Figure 1. Word cloud of food waste

This result demonstrates that waste is largely generated by food material, and food material is closely related

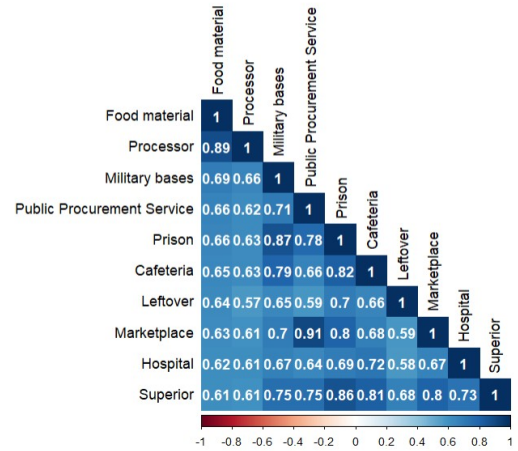


Figure 2. Visualization of correlation matrix (showing correlation equivalent to and higher than 0.5)

Table 2. TF, tf-idf (inverse document frequency)

Ranking	Based on TF-IDF			
	Keyword	TF	Keyword	TF-IDF
1	Food material	11881	Food material	21.470
2	Waste	10048	Processor	16.171
3	Garbage	8104	Business	6.850
4	Processor	5902	Rental	6.407
5	In order to	2611	Waste	5.938
6	Workplace	2551	Hayeon	5.877
7	According to	2495	Food waste dewaterer	5.851
8	About	2416	Container	5.288
9	Dispose of	2286	Installation	4.935
10	Give	1879	Pulverizer	4.737
11	Through	1717	Sink	4.685
12	Food waste dewaterer	1435	Factory	4.434
13	Microorganism	1240	Packaging	4.095
14	Comes out	1188	Vegetable	4.021
15	By	1105	Give	3.990
16	Reduce	1044	Company	3.872
17	About	979	Cleame	3.824
18	Pulverizer	965	Compressor	3.822
19	Manufacture	958	Support	3.782
20	due to	928	Microorganism	3.777

to specific types of private companies and public places.

### C. Model Evaluation for Topic Extraction

This study used the evaluation metrics of perplexity including Griffiths2004, CaoJuan2009, Arun2010, and Deveaud2014 and other metrics (e.g., density, within-topic divergence, across-topic divergence, and log-likelihood) to decide the appropriate number of topics. The right number of topics  $k$  was determined as 3 after careful evaluation of the aforementioned metrics, as shown in Figures 3 and 4. The current study conducted LDA.

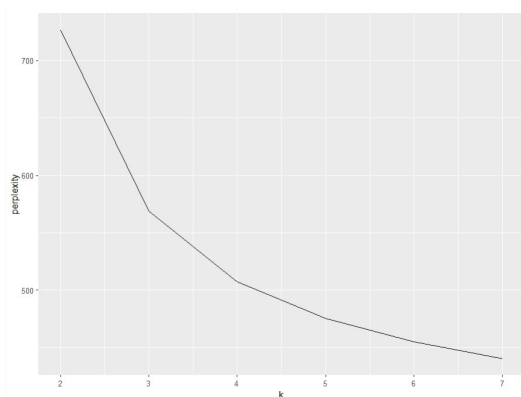


Figure 3. Evaluation metric of perplexity

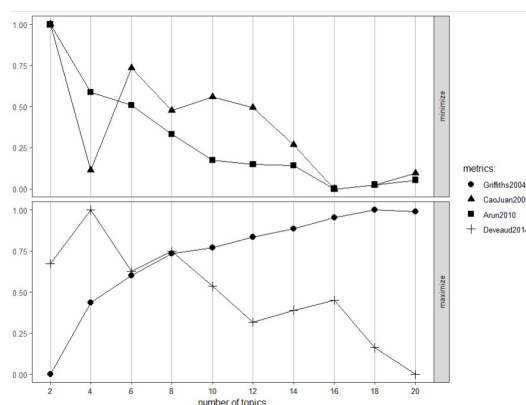


Figure 4. Metrics for evaluating the number of topics

### D. Dimensions of LDA

The current study has attempted to extract dimensions from the collected Naver Blog text of food waste. The LDA identified three topics on the basis of extracting dimensions of topics inherent in the food waste data, as shown. The relative importance in consideration of each topic's proportion was recognized on the basis of the proportion of documents allocated to each topic.

First, Topic 2 ( $n=360$ , 41.47%), with the greatest proportion based on the number of documents being allocated to the given topic, relates to the recent equipment and technologies used for food waste processing, as associated keywords in this topic consist of food, processor, waste, garbage, food waste dewaterer, microorganism, workplace, bean sprouts, cafeteria, sink, and bulk. Therefore, as far as Topic 2 is concerned, the recent methods and technologies in order to process food waste was one of the primary concerns within the food waste data in Incheon and its associated terms centered on the recent ways of minimizing food waste produce such as processor, dewaterer, pulverizer, and compressor in several business operations such as food-related workplaces, restaurants and cafeterias.

Second, as food-related workplaces produce a large amount of food waste, as mentioned earlier, the second most important topic, Topic 1 ( $n=290$ , 33.41%), is related to implications for food waste produced by the workplace. This topic mainly addresses the issue on the basis of keywords including waste, workplace, garbage, plastic, Gyeong-gu, energy, a range of food items and greenhouse gas. The verb keywords (e.g., 'dispose of') were found to be used to express a range of activities related to dealing with waste generated. While a series of basic regulations/guidance on food waste management are well prescribed in relevant Korean legal legislation such as the Waste Control Act and Framework Act on Resources Circulation, these legal enforcements promote specific requirements relating to a variety of waste produced by diverse businesses including construction, people's domestic activities and foodservice businesses. In this regard,



this topic largely discusses the situation where food waste is produced by different types of food-related business workplaces and there is a need for controlling the disposal of waste generated.

Another topic (Topic 3) largely relates to the effect of type of waste on the environment and call for remedies. This theme (n=218, 25.11%), extracted from the food waste data, came mainly from several terms including garbage, waste and disposable. Specifically, this theme has addressed the fact that the specific type of waste being disposed of (e.g., disposable) produces negative influences on the environment. This situation is likely to attract people's attention so that individuals may take action to tackle the environmental problems caused by food waste resulting from various types of foodservice outlets. Additionally, the result shows that given that attention is paid to the influence this type of waste and garbage and disposable will place on various surrounding environments, the behavioral activities such as place an influence, make, caused by, come out and the like have received much attention.

## V. Discussion and Conclusion

The current study aimed to understand the topics surrounding food waste and to provide insight into contemporary food waste issues related to Incheon for the better management of food waste in large quantities employing the analysis of the Naver Blog corpus. This study has employed the R program for the analysis of 868 Naver Blog posts which included information about food waste, and/or garbage in the context of Incheon.

The existing literature has paid attention to the significant influence of food waste on the environment. Indeed, it is often argued that foodservice operators, including commercial and non-commercial catering, have been known to produce a large amount of waste, which is likely to place hazardous impacts on the natural environment (Martin-Rios, Meier, & Pasamar,

2022). However, a large amount of research on food waste has concentrated on the understanding of the reduction and/or generation of food waste mainly through industry-driven efforts (including perspectives of customers and managers), as discussed earlier in the section on research into hospitality food waste (e.g., Dhir et al., 2020; Filimonau & De Coteau, 2019; Olavarria-Key et al., 2021; Teng et al., 2022). Hence, little attention has been paid to the contemporary issue of food waste, especially in a specific Asian region such as Incheon. This study has provided several viewpoints from this perspective as follows.

Based on text mining, this study has shed light on contemporary issues in relation to food waste. First, while term frequencies of keywords identified the significant words including food, waste, garbage, processor, workplace, food waste dewaterer, microorganism, plastic, compressor, restaurant, sink, cafeteria, and bean sprouts, top keywords in terms of tf-idf result have illustrated the main stakeholder(s) of the food waste management industry (e.g., the manufacturers of food waste machines such as Hayeon and Cleame; food waste dewaterer, pulverizer) and its related business areas (e.g., rental and installation). Additionally, it is found that the keywords closely correlated with food material included processor (0.88), military bases (0.69), public procurement service (0.66), prison (0.66), cafeteria (0.65), leftover (0.63), marketplace (0.63), hospital (0.62), and superior (0.61). Hence, while existing studies have focused on food waste in several commercial outlets such as restaurants and hotels in Asian regions including China (e.g., Martin-Rios, Zizka, Varga, & Pasamar, 2020; L. Wang et al., 2018), the current study has highlighted an indication that food waste should receive attention from diverse foodservice settings encompassing hospitals, prisons, as well as military bases. Therefore, Incheon Metropolitan City is recommended to provide more detailed statistics about non-commercial sector including prison, military bases and hospital as well as commercial outlets (e.g., restaurants) in terms of food waste produced per month and year. Different district/counties in Incheon is likely to strengthen environment-friendly performance by sharing reliable data on reduced food

waste by presenting the whole supply chain, which needs intra- and inter-departmental collaboration and coordination.

Importantly, as suggested by Martin-Rios et al. (2022), this study has highlighted that waste management initiatives relate to dealing with food-related and non-food waste in the context of commercial and non-commercial foodservice settings. In a similar vein, while Gyeyang-gu, a region in Incheon, has been known for its strong drive for implementing innovative resource circulation policy including the installation of large dewatering machines for domestic food waste in apartments (J. Lee, 2022), Incheon has been dedicated to promoting public awareness about the need to reduce waste arising from human life and industrial activities in line with the Waste Control Act and Framework Act on Resources Circulation. Specifically, topic modeling based on the LDA technique has shed light on three dimensions of food waste as follows. First, LDA has identified the most significant topic, recent equipment and technologies used for food waste processing, whose main keywords included food, processor, waste, garbage, food waste dewaterer, microorganism, workplace, bean sprouts, cafeteria, sink, and bulk. In the same way that divergent ways of treating food waste have been recognized in the food waste dataset, scholars in the literature have paid much attention to sustainable waste management [e.g., Martin-Rios et al.'s (2022) innovative waste management solutions]. In addition, one of the frequently-mentioned methods to treat food waste is the use of microorganisms, as these contribute to sustainable food waste management. Second, the topic of implications for food waste in the workplace is concerned with what businesses ought to do with food waste in consideration of the amount being produced. This result shows that associated keywords in this topic included waste, workplace, garbage, plastic, Gyeyang-gu, energy, a range of food items and greenhouse gas, thus relating the findings to specific regions of Incheon. In this way, the current study has illustrated a need for the involvement of key stakeholders in waste management; that is, local government. It is required that relevant

foodservice operators should dispose of food waste in accordance with the regulations prescribed in the Waste Control Act and the Enforcement Decree of the same Act. Hence, within this topic the discussed issue relates to the importance of dealing with food waste, with special attention to the legal requirements. This has been in line with one recent study by Martin-Rios et al. (2022) which presented results relating to stakeholder involvement. Finally, the final dimension of the food waste corpus was related to the effect of waste on the environment and call for remedies, as LDA has highlighted that people are discussing issues related to the keywords "garbage, waste and disposable, place an influence, make, caused by, and come out". This finding is in line with recent studies which have investigated the influence of food waste on the environment, and asks for a radical transformation of contemporary practices, especially from the so-called high-income nations, for the purpose of setting targets and implementing better practices (Chaudhary, Gustafson, & Mathys, 2018; Vilela et al., 2018). While Incheon has attempted to provide rudimentary, descriptive statistics on food waste generated (e.g., total amount of food waste per year), the given local government is encouraged to provide accurate, reliable and traceable food waste data through the installment of advanced food waste monitoring system employing artificial intelligence and machine learning. More detailed data regarding waste is likely to enable a development of a more specific strategies for tackling the environmental impacts caused by food waste.

The current study has identified some regional characteristics of food waste management given that some regions have received more attention on the Naver Blog site. The diverse stakeholders in the given community (e.g., S. Lee, Lee, Lee and Hyun, 2023) should take this opportunity to promote the issue of food waste processing technology, management of food waste in the workplace, and the effect of waste on the environment in consideration of regional characteristics, in consideration of the number of specific business operations. On the basis of keyword frequencies (e.g., food waste dewaterer, microorganism,

pulverizer, compressor, bean sprouts, cafeteria, etc.), the parties involved in the waste management industry should pay more attention to the development of effective waste management strategies by the hospitality operators in a specific region.

This study's contributions are not without limitations. This study attempted to collect the data from the blog site when aiming to highlight the contemporary issue of food waste associated with Incheon in Korea. Therefore, the results may produce more nuanced information (e.g., sentiments, arguments, opinions, etc.) in the case of collecting from an online community for a specific purpose, where people may interact with one another for a given topic (i.e., Reddit).

## Acknowledgment

An earlier version of this manuscript in Korean was presented at the 93<sup>rd</sup> TOSOK Incheon International Research Conference.

## References

- Betz, A., Buchli, J., Göbel, C., & Müller, C. (2015). Food waste in the Swiss food service industry - Magnitude and potential for reduction. *Waste Management*, 35, 218-226.
- Blei, D. M., Ng, A. Y., Jordan, M. I., & Lafferty, J. (2003). Latent Dirichlet allocation. *Journal of Machine Learning Research*, 3(4/5), 993-1022.
- Cerciello, M., Agovino, M., & Garofalo, A. (2019). Estimating food waste under the FUSIONS definition: What are the driving factors of food waste in the Italian provinces? *Environment, Development and Sustainability*, 21(3), 1139-1152.
- Chaudhary, A., Gustafson, D., & Mathys, A. (2018). Multi-indicator sustainability assessment of global food systems. *Nature Communications*, 9(1), 848.
- Chen, X., Hyun, S. S., & Lee, T. J. (2022). The effects of parasocial interaction, authenticity, and self-congruity on the formation of consumer trust in online travel agencies. *International Journal of Tourism Research*, 24(4), 563-576.
- Chen, X., & Lee, G. (2021). How does brand legitimacy shapes brand authenticity and tourism destination loyalty: Focus on cultural heritage tourism. *Global Business and Finance Review*, 26(1), 53-67.
- Chen, X., Lee, T. J., & Hyun, S. S. (2022). How does a global coffeehouse chain operate strategically in a traditional tea-drinking country? The influence of brand authenticity and self-enhancement. *Journal of Hospitality and Tourism Management*, 51(6), 176-186.
- Cho, Y. (2021). Awareness and resolution of touristification in Korea using social media big data analytics. *Global Business & Finance Review*, 26(1), 68-78.
- Ciccullo, F., Fabbri, M., Abdelkafi, N., & Pero, M. (2022). Exploring the potential of business models for sustainability and big data for food waste reduction. *Journal of Cleaner Production*, 340, 130673.
- de Souza, M., Pereira, G. M., Lopes de Sousa Jabbour, A. B., Chiappetta Jabbour, C. J., Trento, L. R., Borchardt, M., & Zvirtes, L. (2021). A digitally enabled circular economy for mitigating food waste: Understanding innovative marketing strategies in the context of an emerging economy. *Technological Forecasting and Social Change*, 173, 121062.
- Dhir, A., Talwar, S., Kaur, P., & Malibari, A. (2020). Food waste in hospitality and food services: A systematic literature review and framework development approach. *Journal of Cleaner Production*, 270, 122861.
- Eriksson, M., Persson Osowski, C., Malefors, C., Björkman, J., & Eriksson, E. (2017). Quantification of food waste in public catering services - A case study from a Swedish municipality. *Waste Management*, 61, 415-422.
- Filimonau, V., & De Coteau, D. A. (2019). Food waste management in hospitality operations: A critical review. *Tourism Management*, 71, 234-245.
- Filimonau, V., Krivcova, M., & Pettit, F. (2019). An exploratory study of managerial approaches to food waste mitigation in coffee shops. *International Journal of Hospitality Management*, 76(Part A), 48-57.
- Go, E. J., Moon, J., & Kim, J. (2020). Analysis of the current and future of the artificial intelligence in financial industry with big data techniques. *Global Business & Finance Review*, 25(1), 102-117.
- Gu, Z., Zhang, Y., Chen, Y., & Chang, X. (2016). Analysis of attraction features of tourism destinations in a mega-city based on check-in data mining-A case study of shenzhen, china. *ISPRS International Journal of Geo-Information*, 5(11), 210.
- Han, J. H., & An, K. S. (2022). Comparison of perceptions of wellness tourism in Korea before and after COVID-19: Results of social big data analysis. *Global Business & Finance Review*, 27(2), 1-13.
- Hayeon. (n.d.). Retrieved from <http://www.hayeon.net/>
- Jang, H., & Park, M. (2020). Social media, media and urban transformation in the context of overtourism. *International Journal of Tourism Cities*, 6(1), 233-260.
- Jeon, Y. J. J. (2023). An analysis of key attributes of upcycled

- food using a best-worst scaling approach. *Global Business and Finance Review*, 28(5), 1-12.
- Juvan, E., Grün, B., & Dolnicar, S. (2023). Waste production patterns in hotels and restaurants: An intra-sectoral segmentation approach. *Annals of Tourism Research Empirical Insights*, 4(1), 100090.
- Kayikci, Y., Demir, S., Mangla, S. K., Subramanian, N., & Koc, B. (2022). Data-driven optimal dynamic pricing strategy for reducing perishable food waste at retailers. *Journal of Cleaner Production*, 344, 131068.
- Kim, G. (2020). Incheon metropolitan city announces "Comprehensive plan for reducing waste". *Sondo Chronicle*. <https://songdochronicle.com/1961/latest-posts/incheon-metropolitan-city-announces-comprehensive-plan-for-reducing-waste/>
- Kim, M. S. (2022). South Korea has almost zero food waste. Here's what the US can learn. *The Guardian*. <https://www.theguardian.com/environment/2022/nov/20/south-korea-zero-food-waste-composting-system>
- Lee, J. (2022). 인천 계양구, 친환경 거점도시 만든다...자원 순환 선도[Incheon Gyeyang-gu builds an environment-friendly base city...Leading resource circulation]. *edaily [오늘의경제]*. <https://www.edaily.co.kr/news/read?newsId=03024166632266928>
- Lee, J. Y., & Jin, C. H. (2019). The effect of sponsor's brand on consumer-brand relationship in sport sponsorship. *Global Business and Finance Review*, 24(1), 27-43.
- Lee, S., Lee, N., Lee, T. J., & Hyun, S. S. (2023). The influence of social support from intermediary organizations on innovativeness and subjective happiness in community-based tourism. *Journal of Sustainable Tourism*, 1-23.
- Lee, S., Park, J. R., & Ahn, C. H. (2020). Development of Sustainable Food Waste Management for Reducing Greenhouse Gases Emissions in Korea. *Ecology and Resilient Infrastructure*, 7(4), 248-254.
- Mak, T. M. W., Xiong, X., Tsang, D. C. W., Yu, I. K. M., & Poon, C. S. (2020). Sustainable food waste management towards circular bioeconomy: Policy review, limitations and opportunities. *Bioresource Technology*, 297, 122497.
- Mao, K. L., Niu, J. W., Chen, H., Wang, L., & Atiquzzaman, M. (2018). Mining of marital distress from microblogging social networks: A case study on Sina Weibo. *Future Generation Computer Systems*, 86, 1481-1490.
- Martin-Rios, C., Meier, C. D., & Pasamar, S. (2022). Sustainable waste management solutions for the foodservice industry: A Delphi study. *Waste Management & Research*, 40(9), 1412-1423.
- Martin-Rios, C., Zizka, L., Varga, P., & Pasamar, S. (2020). KITRO: Technology solutions to reduce food waste in Asia-Pacific hospitality and restaurants. *Asia Pacific Journal of Tourism Research*, 25(10), 1128-1135.
- Naver. (2021). NAVER Blog Records All-time High of New Entries in 2021. Retrieved from <https://www.navercorp.com/en/promotion/pressReleasesView/30756>
- Nilashi, M., Baabdullah, A. M., Abumalloh, R. A., Ooi, K. B., Tan, G. W. H., Giannakis, M., & Dwivedi, Y. K. (2023). How can big data and predictive analytics impact the performance and competitive advantage of the food waste and recycling industry? *Annals of Operations Research*, 42. doi:10.1007/s10479-023-05272-y
- Olavarria-Key, N., Ding, A., Legendre, T. S., & Min, J. (2021). Communication of food waste messages: The effects of communication modality, presentation order, and mindfulness on food waste reduction intention. *International Journal of Hospitality Management*, 96, 102962.
- Praesri, S., Meekun, K., Lee, T. J., & Hyun, S. S. (2022). Marketing mix factors and a business development model for street food tourism. *Journal of Hospitality and Tourism Management*, 52(6), 123-127.
- Principato, L., Pratesi, C. A., & Secondi, L. (2018). Towards Zero Waste: an Exploratory Study on Restaurant managers. *International Journal of Hospitality Management*, 74, 130-137.
- Qiao, T., Shan, W., Zhang, M., & Wei, Z. (2022). More than words: Understanding how valence and content affect review value. *International Journal of Hospitality Management*, 105. doi:10.1016/j.ijhm.2022.103274
- Shao, X., Jeong, E., Jang, S., & Xu, Y. (2020). Mr. Potato Head fights food waste: The effect of anthropomorphism in promoting ugly food. *International Journal of Hospitality Management*, 89, 102521.
- Talwar, S., Kaur, P., Okumus, B., Ahmed, U., & Dhir, A. (2021). Food waste reduction and taking away leftovers: Interplay of food-ordering routine, planning routine, and motives. *International Journal of Hospitality Management*, 98, 103033.
- Teng, C.-C., Wang, Y.-C., & Chuang, C.-J. (2022). Food choice motives and dining-out leftover prevention behavior: Integrated perspectives of planned behavior and norm activation. *International Journal of Hospitality Management*, 107, 103309.
- Vilela, C., Kurek, M., Hayouka, Z., Röcker, B., Yildirim, S., Antunes, M. D. C., ... Freire, C. S. R. (2018). A concise guide to active agents for active food packaging. *Trends in Food Science & Technology*, 80, 212-222.
- Vizzoto, F., Testa, F., & Iraldo, F. (2021). Strategies to reduce food waste in the foodservices sector: A systematic review. *International Journal of Hospitality Management*, 95, 102933.
- Vu, H. Q., Li, G., & Law, R. (2019). Discovering implicit activity preferences in travel itineraries by topic modeling. *Tourism Management*, 75, 435-446.
- Wang, L., Xue, L., Li, Y., Liu, X., Cheng, S., & Liu, G. (2018). Horeca food waste and its ecological footprint in Lhasa, Tibet, China. *Resources, Conservation and Recycling*, 136, 1-8.
- Yang, W. S., Park, J. K., Park, S. W., & Seo, Y. C. (2015). Past, present and future of waste management in Korea. *Journal of Material Cycles and Waste Management*, 17(2), 207-217.