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Food for Thought in Malaysian Borneo: Data Mining and Sentiment Analysis of Tripadvisor Reviews for Online Destination Branding

*James Mountstephens[1], Balvinder Kaur Kler[2], Siao Fui Wong[3],
[1]Faculty of Computing, Universiti Malaysia Sabah, 88400 Kota Kinabalu, Malaysia
[2]Borneo Tourism Research Centre, Faculty of Business, Economics and Accountancy,
Universiti Malaysia Sabah, Kota Kinabalu, Malaysia
[3]MODUL School of Tourism and Hospitality Management Nanjing, Nanjing Tech University Pujiang Institute,
Lishui District, Nanjing, Jiangsu Province, China
*james@ums.edu.my, balvinder@ums.edu.my, siaofui.wong@modul.ac.at
Corresponding Author: James Mountstephens

Abstract: Unique destination branding in tourism is crucial to gaining a competitive advantage. Local food is a significant component of a destination brand which Destination Management Organisations (DMOs) must integrate into their official marketing efforts. DMOs must monitor the popularity and perception of their food promotions against the competition. Online promotion and management are challenging due to the rise of user-generated content. Automatic data mining techniques were used to determine the extent to which tourist food choices on TripAdvisor matched foods promoted by DMOs and how distinct these choices were from a rival DMOs' promotion. We compared online food promotion between the Sabah Tourism Board and the Sarawak Tourism Board. We developed a software system to automatically extract food branding business intelligence from TripAdvisor restaurant reviews. The application of web crawling and scraping technology was applied to extract data and use Sentiment Analysis for interpretation. Online foods promoted by DMOs for each region were found to contain only a few common dishes, but these were more popular than region-specific foods. Significantly different distributions of food choices were found for each region. Some potentially useful differences between foreign and domestic tourists and locals were also identified. Sentiment analysis revealed hidden information in reviews useful for potential food destination branding. Findings from TripAdvisor confirm practical suggestions for improving brand distinctiveness found in the literature. This study is the first to develop an actual system that DMOs could use to estimate the online popularity of their promoted foods and those of their competition.

Keywords: *Destination Branding, Local Food, Data Mining, Sentiment Analysis, TripAdvisor, Malaysian Borneo*

1. Introduction

In the tourism industry, effective destination branding is crucial to gaining a competitive advantage (Rinaldi & Beeton, 2015). Brands are complex and consist of destination attributes ranging from the purely physical, and historical to the cultural. Good branding distinguishes a destination from comparable others to reduce the gap between projected and perceived image (Költringer & Dickinger, 2015). This can be especially difficult when destinations are geographically adjacent but culturally similar. Destination Management Organisations (DMOs) are responsible for producing, promoting and managing an official destination brand through a variety of channels (Pike & Page, 2014). DMOs need to track and manage public opinion toward the various aspects of the destination brand. DMOs must know whether the products promoted are popular and viewed positively; ideally according to different demographics such as domestic and foreign tourists. Any perceived issues with their brand and opportunities for improvement must be identified and addressed to enhance destination competitiveness (Pike & Page, 2014). DMOs also monitor the overlap between their promotions and those of the competition.

Local food is a significant tourism product that contributes to a destination brand (Ellis et al., 2018) and is the aspect of destination branding considered in this study. Local food is integrated into official destination marketing efforts by DMOs (Choe & Kim, 2018; Björk & Kauppinen-Räisänen, 2016). Stalmirska (2021) suggests local food has varied definitions categorizable into geographic, cultural, and socio-economic dimensions. Notably, local food is an important element of tourist destinations, representing culture and providing a learning opportunity for tourists (Ellis et al., 2018; Björk & Kauppinen-Räisänen, 2016). Gastronomic tourism is a significant niche market for most destinations (Berbel-Pineda et al., 2019). However, a recent study indicates cuisines are neither fully utilized nor skilfully integrated into destination marketing

efforts (Okumus et al., 2018). Attempts have been made to clarify how DMOs could use gastronomic events to enhance destination competitiveness (Nelson, 2021; Stalmirska, 2021; Pivčević & Lesić, 2020). As advocated by Lai et al. (2017) there exists a dual-perspective review of food image: one projected by destination marketers, the other a mental representation as perceived by tourists and an understanding of both is essential for building a positive brand image. Food, culinary experiences, and gastronomy are used in tourism by DMOs, governments and industry groups for place branding (Gulisova, 2022). Debates in the literature discuss whether gastronomy is used for place branding or whether place brand influences the perception of gastronomy (Gulisova, 2022). Other questions include whether gastronomy is authentic, exclusive, market-driven, single cuisine, multicultural or cosmopolitan (Gulisova, 2022).

With the advent of Web 2.0, destination branding is no longer under the sole purview of official entities. Online promotion and management are necessary nowadays due to the rise of User Generated Content (UGC) in the form of social media, blogs, and travel review sites (Mariani, 2020). In tourism destination marketing, UGC is a cost-effective communication means to promote destinations online (Mariani, 2020). An important class of UGC is found on travel review websites such as TripAdvisor (TA) comprised of voluntary unpaid contributions from virtual members. TA is used by 455 million unique visitors per month from all over the world (Putri & Kusumaningrum, 2017; Rossetti et al., 2016) and contains over 570 million reviews concerning accommodations, airlines, attractions, and restaurants. TA has been used as a source of customer opinion in tourism studies but focused on scenic spots or cruising or were general (Li et al., 2021; Tao & Kim, 2019; Schuckert et al., 2016). More recently, Lim et al. (2019) studied how online food reviews influenced tourists' behavioral intention toward ethnic foods in the context of Gen-Y tourists in Malaysia and discovered a direct relationship suggesting the result of reading online reviews increases involvement and intention to seek out local food. However, their paper did not focus solely on TA reviews and gaps remain in extracting, interpreting, and applying TA reviews which could provide insights for DMOs for destination branding.

For destination branding, DMOs could use TA to monitor their local food promotions since it contains restaurant reviews that describe foods consumed by tourists. It is also possible to find all restaurant reviews for a particular destination and to find a subset of reviews that contain a particular keyword. However, TA has several limitations as a tool for branding. First, it is not directly possible within TA to find reviews for a list of many foods, which may each go by several names, nor to compile informative and useful statistics for this list which might aid food branding. For example, if a DMO promotes 20 different foods then it should be possible to find out the popularity of each food by the number of reviews it has, and to also determine how positively it is seen after consumption.

Secondly, reviews cannot be broken down according to whether the reviewer is a foreign or domestic tourist or a resident. This information could be important for assessing the impact of DMO promotions which are aimed primarily at foreign tourists. And TA, like many review sites, has a simplistic overall rating system of 0 to 5 stars, rather than ratings for individual content, making it possible that the rating will not reflect the specific content of interest. For example, there are many zero-star reviews on Amazon.com where the reviewer loved the product but hated the delivery or customer service (Valdivia et al., 2017). To avoid misleading ratings, a finer-grained analysis of review text with analysis at a sentence level is required. In principle, DMOs could extract all this information from TA by manually querying restaurants and foods, reading thousands of reviews in detail to identify and record references to foods, making judgments about opinions in individual sentences, and compiling statistics. Considering the sheer number of TA reviews, this would require considerable time and effort, which would have to be repeated from scratch if the list of promoted foods ever changed.

Due to these practical limitations, a software system able to automatically perform these tasks could be highly beneficial for DMOs. Indeed, the application of computer-based methods taken from data mining is a wider trend in tourism studies that has demonstrated itself. Much recent work has been carried out using data mining techniques, on TA and other UGC in a tourism setting, including Sentiment Analysis (SA). "Sentiment analysis, or opinion mining, is an active area of study in the field of natural language processing that analyses people's opinions, sentiments, evaluations, attitudes, and emotions via the computational treatment of subjectivity in the text" (Hutto & Gilbert, 2014, p.217). SA aims to determine positive and negative attitudes contained in the text and has been applied in tourism studies (Ren & Hong, 2017; Valdivia et al., 2017; Becken et al., 2020; Bruno et al., 2019; Chen et al., 2020; Yu & Zhang, 2020). Few studies have explicitly considered how DMOs can utilize

data mining methods and SA in their destination branding efforts (Filho, 2020; Franzoni & Bonera, 2019). In this respect, our study attempts to address this deficiency.

We aimed to develop a software system to replace the human effort required to extract food branding business intelligence from TA restaurant reviews. This required the application of web crawling and scraping technology to extract relevant data, and the use of SA to interpret it. The type of SA was aspect-based (Valdivia et al., 2017), meaning that it was specifically conducted on review sentences regarding local food and no other features of the review. Although practical suggestions for DMOs on how to use local food as a destination marketing tool are available (Choe & Kim, 2018), this study is the first to develop an actual system that DMOs could use to estimate the online popularity of their promoted foods and those of their competition. For this purpose, we chose to focus on Malaysian Borneo, a food haven in South East Asia.

According to Zainal et al. (2010) to experience gastronomy in Malaysia, it is best to visit the peninsular states of Melaka, Perak, Penang and Borneo regions of Sabah and Sarawak. Malaysia is well-known as a food paradise due to the fusion of the culinary traditions of its diverse ethnic communities (Hussin, 2018). Recent studies on food tourism as a tool for destination branding in Malaysian Borneo have not looked at online reviews of food. Ting et al. (2019) studied tourists from Peninsular Malaysia, Sabah, Singapore, and Indonesia to examine their intention to consume Dayak food when they visit Sarawak, Malaysia; findings identified differences from conative perspectives. Fam et al. (2020) examined factors that influence the consumption of Kadazan-Dusun food between foreign (China, Europe) and domestic (Malaysian) tourists uncovering some similarities. However, Fam et al. (2020) found sensory appeal influenced food choice for the China market whereas convenience and mood influenced food choice for the domestic market. There remains a dearth of knowledge on tourist sentiments towards local foods promoted by DMOs in Malaysian Borneo. Therefore, this study chose the DMOs from the Malaysian Borneo regions of Sabah and Sarawak. Although adjacent to one island, each has distinctive local foods and was considered a good case study for branding distinctiveness. The research questions, underpinned by the objectives, are as follows: [1] What local food is being promoted by DMOs in Malaysian Borneo? [2] what is tourist sentiment towards local food on TA for Malaysian Borneo? [3] how distinct are tourist food choices between two rival DMOs food promotions? We aimed to evaluate the promotion of local food by the DMOs of Sabah and Sarawak against TA reviews using data mining techniques and an SA system developed for this purpose. Could gastronomy be a factor of internal differentiation according to TA reviews?

This paper begins with an introduction to the context which will justify the choice of Malaysian Borneo as the case study. Specifically, this section presents an insight into the types of local foods being promoted on the respective regional DMOs' websites. We pinpoint the overlap between the two regions' food promotions including foods unique to the region, foods common to both regions and foods unique to the other region. Next, we outline the TA data mining systems developed for this study followed by the SA algorithm used to analyze food reviews for each region. Findings and discussion deliberate on the popularity of DMOs-promoted foods overall and in detail for each region. Finally, we evaluate the effectiveness of DMO's food promotion online.

2. Context of the Study

Malaysia has three geographic regions, Peninsular Malaysia, Sabah and Sarawak across the South China Sea on Borneo Island, the third largest island in the world with an area of 743,330 km^2 situated in Southeast Asia. Borneo is shared by three nations: Malaysia Brunei Darussalam, and Indonesia (region of Kalimantan) (see Figure 1). Malaysian Borneo offers unique tourist experiences different from those in Peninsular Malaysia. Sabah and Sarawak are melting pots of cultural diversity, and both utilize 'Borneo' in their tourism destination brand promoting the exotic wilderness and culture of Borneo. These bordering regions are culturally diverse yet share similar tourism offerings of nature, adventure, and culture (Kler & Wong, 2018) promoted by regional DMOs.

Figure 1: Sabah and Sarawak within Malaysia

Sabah Tourism Board (STB) markets "Sabah, Malaysian Borneo as the premier nature adventure destination in the world" (www.sabahtourism.com). Sabah on the northern portion of Borneo has an established tourism industry based on rainforests, iconic wildlife (orang utan and proboscis monkeys), national parks (terrestrial and marine) and culture. Sabah has over fifty main ethnic groups with their languages of which thirty-two comprise the Indigenous Dusunic, Murutic and Paitanic families of Austronesian languages (Kitingan, 2015, p. 269). Sabah is also home to other Austronesian communities including the Bajau (Sama Family), the Brunei and Kadayan, and the Iranun, as well as non-Austronesian peoples (Chinese and Indians), products of migration (Kitingan, 2015). The largest Indigenous group in Sabah is the *Kadazan Dusun* for whom Indigenous dishes are reflective of their traditions, culture and practices including the *Hinava (*flavourful raw fish salad), *Ambuyat* (a sticky dish made from sago palm starch), *Jeruk Bambangan* (a preserved condiment made of wild mango endemic to Sabah), *Tuhau (a pungent condiment made of wild ginger endemic to Borneo), Lihing (rice wine), Pinasakan* (fish dish) and *Bosou* (tangy fermented meat) (Fam et al., 2020). Sarawak Tourism Board (ST) promotes itself as a home to adventures of the wilderness and cultural diversity. Longhouses are a unique way of life for the indigenous people. Sarawak is known as 'The Land of the Hornbills' as these birds are symbolic of the *Dayak*. According to the Sarawak constitution, a *Dayak*, or an Indigenous person is legally defined as all non-Muslim natives (Weinlein, 2017). Fifty percent of the population here consists of indigenous people including the *Iban, Kayan, Penan* and *Bidayuh* groups (Weinlein, 2017). Other groups include the Malays, Chinese and small immigrant societies from both Asian and European backgrounds (Ting et al., 2019). According to Ting et al. (2019), traditional Dayak food includes *Tubu* (stems), *Tuak* (an alcoholic beverage made from rice wine) and *Pansuh* (meat cooked with bamboo) prepared and cooked using natural resources from the forest. Sarawak ethnic cuisine is unique due to the local ingredients, cooking processes and practices embedded within the different ethnic groups in the region (Wan Sageng et al., 2020). The next section evaluates the local foods promoted by each DMO.

Online Food Promotions: Sabah Tourism Board versus Sarawak Tourism Board

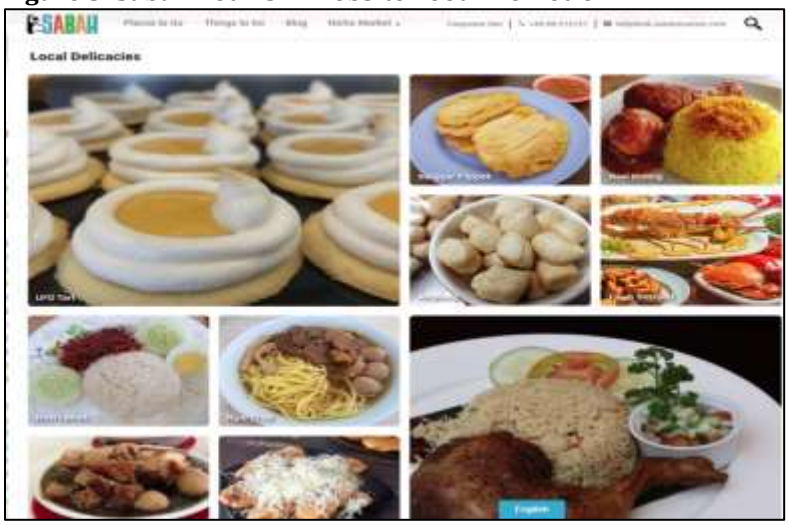
STB's website (https://www.sabahtourism.com/what-to-eat/) promotes 15 different foods on a single page entitled "What To Eat" which is accessible directly from the homepage.

Figure 2: Sabah Tourism Promoted Foods

Laksa, Amplang, Ngiu Chap, Beaufort Mee, Seafood, Bah Kut Teh, Satay, Nasi Ayam, Nasi Lemak, Soto, Pisang Goreng, Fish Head Curry, UFO Tart, Sangar Pappek, Nasi Kuning

Foods are presented using large, attractive pictures that can be clicked for more detail. Figure 3 (overlead) shows some of the foods promoted.

Figure 3: Sabah Tourism Website Food Promotion

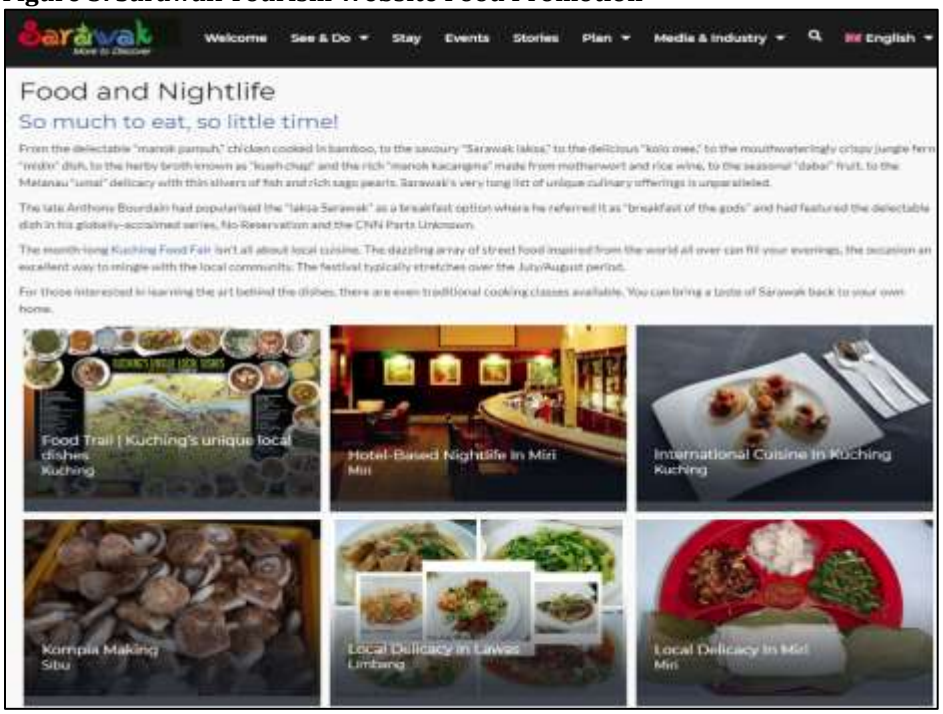


ST's promotion (https://sarawaktourism.com/attractions_type/food-nightlife/) is far less focused than that of STB. Their website provides a combined "Food and Nightlife" section where a total of 43 foods are found scattered across 19 separate pages. The foods are not specifically listed and are simply part of paragraphs describing various events and restaurants. There are also two pages promoting Western and International foods rather than local food in this section. ST promotes a total of 43 foods:

Figure 4: Sarawak Tourism Website Food Promotion

laksa,kolo mee,manok pansoh,kek lapis,umai,midin,kompia,kampua, nuba laya, kueh chap,gula apong, ngiu chap, seafood, satay, nasi lemak, ayam penyet, roti canai, mee jawa, beehoon, lalapan ayam, mee mamak, mee sua, fish soup, rice porridge, belacan beehoon, kedondong juice, fish balls, daun ubi, mixed pork soup, kopi c, belacan midin, mee udang, roti arab,soya bean milk, beehoon cangkuk manis, fried dabai rice, grilled three layered pork, lamah,linut ambuyat, manok gulai terung asam, petai belacan, sago linut, tempoyak fish

Figure 5: Sarawak Tourism Website Food Promotion

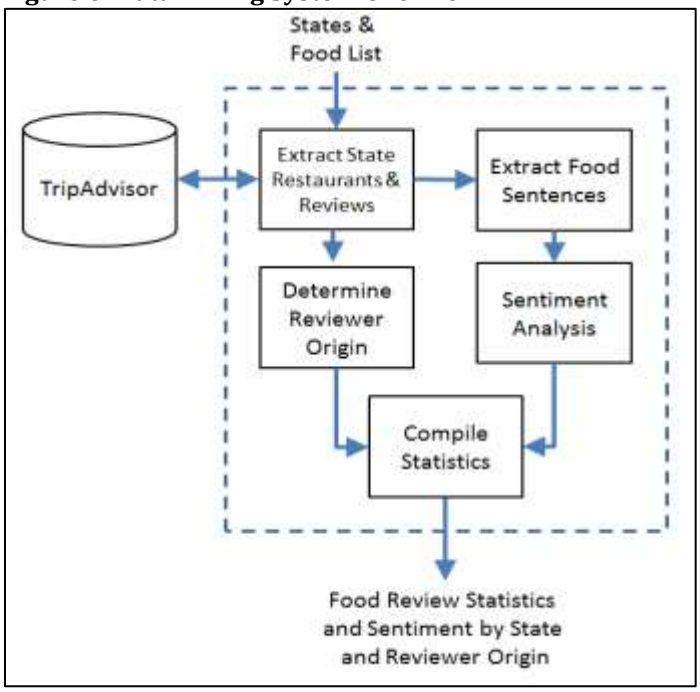


There is some overlap between DMO promotions. Both DMOs promote the five common dishes: *Seafood, Nasi Lemak, Satay, Ngiu Chap*, and *Laksa.* There are thus three food classes to consider for each DMO promotion: (i) foods unique to the region (Sabah 10, Sarawak 38); (ii) foods common to both regions (5); and (iii) foods unique to the other region (Sabah 38, Sarawak 10). Accounting for the five (5) common foods, the combined list of DMO-promoted foods contains 53 dishes. Notably, the commonly promoted dishes are at odds with informal knowledge of what are strictly "local foods". Seafood is not considered to be a traditional food of the local people of either Sabah or Sarawak. STB actively promotes *Laksa* which is perceived as very strongly specific to Sarawak, whereas ST promotes *Ngiu Chap* which is perceived as moderately specific to Sabah. Notably, *Satay* and *Nasi Lemak* are generic Malaysian foods with neither being region-specific. Despite the overlaps in promoted foods, there is still a good overall separation between DMO promotions. The five (5) common foods constitute only 33% of STB's foods and just 12% of foods by ST. If we assume that all foods are equally popular, the distinction between DMO promotions is supported by a highly negative correlation (r = -0.77) between the list of foods for each region. However, the practical significance of the overlap in promotion will only be seen by the number of reviews for these common foods versus region-specific dishes, which will be determined by data mining presently.

3. Materials and Method

The basic outline of our TA data mining system is shown in Figure 6. Custom Python code was written to crawl and scrape restaurants and reviews for a given list of regions and foods. In this case, the regions were Sabah and Sarawak and the list of foods was from the DMOs (states and food lists). Within each review, individual sentences for foods were extracted and subject to SA. Reviewer origin (nationality of the reviewer) was estimated by comparing the reviewer's location with lists of towns in both Sabah and Sarawak. Food review and SA statistics were then compiled for reviews according to region and reviewer origin.

Figure 6: Data Mining System Overview



The particular SA algorithm used was VADER (Valence Aware Dictionary for Sentiment Reasoning) in its freely available Python implementation (Hutto & Gilbert, 2014). VADER can achieve an F1 score of 0.96 on social media text and is a highly cited algorithm (Hutto & Gilbert, 2014). It should be noted that like most SA algorithms, when given a sentence to analyze, VADER will output a value between -1 and +1 meaning strongly negative or strongly positive and with 0 indicating neutral sentiment. Scores of +1 or -1 are theoretical ideals and in practice, scores of around -0.3 and +0.3 are considered highly negative or positive for everyday day text.

A total of 2,294 restaurants were found on TA for Sabah and Sarawak, with approximately equal numbers for each region. All reviews for each restaurant were crawled and scraped from TripAdvisor and stored locally for analysis. In total, 22,387 reviews were extracted, again with approximately half for each region. Then, each review was processed to identify those which were about the foods promoted by each DMO.

4. Findings and Discussion

Overall Popularity of DMO Promoted Foods

The most basic level of popularity data required by a DMO would be the percentage of total reviews for their foods, both collectively as a set of promoted dishes, and individually to identify relative popularity within their promotion. This would be done compared to all other available foods (for example, Western, Middle Eastern, Japanese) which compete less directly compared to the other regional DMOs foods (direct competition).

Table 1 denotes 2,871 reviews in Sabah restaurants that appraised 15 STB foods, and 3,488 reviews in Sarawak restaurants that evaluated the 43 ST foods.

Table 1: Number of Reviews for Sabah and Sarawak Restaurants on TripAdvisor

State	Restaurants	Reviews	Reviews containing foods promoted by State DMO
Sabah	1,169	11,954	2,871 (24%)
Sarawak	1,125	10,433	3,488 (33%)

There is some degree of overcounting in the totals above since a single review may sometimes contain references to more than one food. This notwithstanding, it was evident that STB and ST-promoted foods are referenced in 24% and 33% of all restaurant reviews in their respective regions. One's expectations and goals for market share will determine how impressive these percentages are but, given the vast number of foods available in Sabah today, 24% of all region restaurant reviews for only 15 specific foods can be considered quite respectable. With 33% of reviews, ST foods are certainly found in a greater proportion of restaurant reviews, but this may simply be the result of having almost three times as many foods under promotion than Sabah.

These percentages can help DMOs estimate the overall popularity of their promoted foods versus all other available food choices (Western, Middle Eastern, Japanese). It is reasonable to want an exhaustive list of those other foods that account for the remaining 76% and 67% of food reviews. However, that data mining task is of a different type to the one conducted here and is known to be extremely difficult with current methods. Whilst it is relatively straightforward to find text containing known food types, determining a set of unknown food types is a problem of Named Entity Recognition which is still immature for open-ended domains like the current one. This will be the topic of future work. Therefore, the following analysis will only concern evaluating the relative popularity of the 53 DMO-promoted foods. It was noted earlier that there is overlap in the foods promoted by the DMOs and that this overlap defines three classes of foods: those unique to each region, those common to both, and those foods of the other region. It is useful to identify the distribution of reviews according to these three classes as shown in Table 2.

Table 2: TripAdvisor Reviews broken down by DMOs

State	Unique State DMO foods	Common DMO foods	Other state DMO's foods
Sabah	449	2,422	244
Sarawak	1,252	2,236	323

It was evident most reviews for both regions are about the five foods common to both promotions. In Sabah, these common foods account for 85% = 2,422 / (449+2,422) of total DMO reviews. In Sarawak, common foods account for only 64% of reviews (2,236 / (1,252+2,236) meaning that more uniquely ST foods are reviewed. Also shown is the percentage of reviews within region restaurants for foods promoted exclusively by the other DMO. For Sabah, uniquely Sarawak foods are of the same order of magnitude as uniquely Sabah foods. Sarawak has a similar number of reviews for uniquely Sabah foods, but this is offset by the greater number of reviews for region-only foods. Again, this may be due to the greater number of foods promoted by Sarawak. After this basic analysis of food popularity, DMOs might next want to study the distribution of reviews over individual foods and use SA to monitor customer perception of reviews.

Detailed Popularity of DMO Promoted Foods

The grouped review counts shown in Table 2 were broken down to show the individual popularity of the 53 promoted foods within each region. Each sentence containing a DMOs promoted food was subject to SA using the VADER algorithm and the mean sentiment for each food type was calculated. Also extracted was the mean TA rating for the reviews containing references to each food. The results are shown in Tables 3 and 4 for Sabah and Sarawak restaurants, respectively.

Sabah Tourism Promoted Foods

Table 3: TripAdvisor Popularity and Sentiment for DMO promoted foods in Sabah Restaurants

	Food	# of Reviews	% of Reviews	Mean Sentiment	Mean TA Review Rating	Sabah Tourism Promoted	Sarawak Tourism Promoted
1	seafood	1961	63	0.34	0.60	√	√
2	nasi ayam	263	8	0.27	0.52	√	
3	laksa	164	5	0.34	0.64	√	√
4	nasi lemak	120	4	0.23	0.48	√	√
5	satay	99	3	0.28	0.61	√	√
6	ngiu chap	78	3	0.37	0.67	√	√
7	fish soup	75	2	0.43	0.70		√
8	roti canai	73	2	0.40	0.62		√
9	bah kut teh	68	2	0.33	0.58	√	
10	Soto	56	2	0.26	0.54	√	
11	fish head curry	34	1	0.38	0.59	√	
12	ayam penyet	30	1	0.27	0.56		√
13	kolo mee	26	1	0.38	0.72		√
14	fish balls	12	< 1	0.18	0.43		√
15	pisang goreng	9	< 1	0.19	0.82	√	
16	ufo tart	8	< 1	-0.08	0.45	√	
17	beehoon	7	< 1	0.34	0.54		√
18	mee mamak	7	< 1	0.06	0.77		√
19	nasi kuning	6	< 1	0.20	0.53	√	
20	umai	4	< 1	0.27	0.40		√
21	Beaufort mee	4	< 1	0.23	0.50	√	
22	mee jawa	3	< 1	0.03	0.20		√
23	kopi c	3	< 1	0.18	0.60		√
24	kampua	1	< 1	0.21	0.60		√
25	kek lapis	1	< 1	0.13	1.00		√
26	mee sua	1	< 1	0.00	0.60		√
27	rice porridge	1	< 1	0.00	-0.60		√
28	amplang	1	< 1	0.00	0.60	√	
		Total 3,115	**Total 100**	**Mean 0.22**	**Mean 0.55**	**Total 14/15**	**Total 19/43**

As seen in Table 3, only 28 of the 53 DMO-promoted foods were reviewed in Sabah at all but nearly all of the 15 STB foods were reviewed, with only *Sanggar Pappek* (banana fritters served with spicy condiment) receiving no reviews. However, the popularity of these 14 foods is highly uneven. Seafood is overwhelmingly the most popular food, accounting for 63% of all reviews. Its high popularity is also found with a mean

sentiment of 0.34, which is impressively positive. In comparison, the next most popular food, *Nasi Ayam* (chicken rice), accounts for only 8% of reviews but it too has good positive sentiment. *Nasi Ayam* is the most popular food that is uniquely promoted by STB. Confirming the suggestion of Table II, it is evident that all five of the commonly promoted foods are in the top ten, and that the other unique promotions are far less popular. The unique foods *Pisang Goreng* (banana fritters), *UFO Tart* (local tart), *Beaufort Mee* (local noodles), and *Nasi Kuning* (yellow rice) are borderline unpopular by review count.

These manual observations can be quantified by calculating the correlation between the number of reviews for each food and the lists of foods promoted by each DMO. Overall, Sabah restaurant food review counts correlate with STB food promotion at r = 0.31, which is a moderate positive relation. Of course, cause cannot be conclusively determined by this analysis, since STB could simply be promoting what they already know to be popular, but this is still a respectable level of consistency.

Mean TA review ratings are also listed in Table III. These ratings have been transformed from the original range (0 to 5) to the range (-1 to +1) to allow comparison with the results of SA. Sentiment and rating are found to correlate at r = 0.35 which at a gross level is reassuring since total divergence between ratings and sentiment would be cause for concern. However, inspection reveals several differences between sentiment and rating that are missed in this overall correlation. These may reveal food-specific opinions that are missed in overall review ratings. In particular, review sentences about *UFO tart* were found to have a mean negative sentiment, but the overall ratings of the relevant restaurant reviews are still positive. On detecting such a divergence, a DMO can use our system to retrieve the original review text for manual analysis to confirm this finer-grained opinion. For *UFO tart*, it was found that some of the raw reviews featured negative opinions that are missed in the review rating, but detected by SA at a sentence level, as shown in Table VI below. This demonstrates the potential of aspect-based SA for better market awareness which can prompt DMOs to manage these negative opinions.

Table 4: Divergence between TA review ratings and food sentences

Overall TA Review Rating (0-5)	Specific Sentences on UFO Tart
3	"Do not order the UFO tart here even is Sandakan speciality."
2	"One of the most overrated UFO tarts I ever tasted"
5	"Unfortunately, they no longer offer UFO tarts...."

After considering Sabah restaurant reviews about STB food promotion, a DMO can also study how they relate to direct competition. Sabah restaurant food review sentences correlate with ST food promotion at r = 0.02 which is close to uncorrelated. This result is achieved despite the high popularity of the five commonly promoted foods because i) ST has so many more foods and ii) most that are unique to Sarawak have few or no reviews in Sabah. So, for STB, this combination of moderate correlation with promoted foods but low correlation with ST foods can be considered a good result.

Sarawak Tourism Promoted Foods

The analysis for ST is shown in Table 5 below. While seven of the same foods are in the top 10 for both regions, these are distributed very differently in Sarawak. These include s*eafood, nasi ayam* (chicken rice), *laksa* (spicy noodles), *nasi lemak* (fragrant rice cooked in coconut milk and pandan leaves served with condiments), *satay* (skewered meat), *Ngiu Chap* (beef noodles), *roti canai* (fried unleavened bread served with curry). Additionally, the exclusively Sarawakian dish *Kolo Mee* (dry-style noodles served with meat) is ranked highly only in Sarawak (14% versus 1% of sentences in Sabah). Similarly in Sabah, *Seafood* is the most popular promoted food, but in Sarawak, seafood accounts for far fewer reviews and is also slightly less positively viewed. Other foods are comparably popular with seafood. *Laksa*, which belongs strongly to Sarawak, is consumed almost as much as *Seafood* and nearly four times more frequently than in Sabah. *Kolo Mee* is also Sarawakian but very popular in Sabah.

Table 5: TripAdvisor Popularity and Sentiment for DMO promoted foods in Sarawak Restaurants

	Food	# of Reviews	% of Reviews	Mean Sentiment	Mean TA Review Rating	Sabah Tourism Promoted	Sarawak Tourism Promoted
1	seafood	1016	27	0.31	0.57	√	√
2	laksa	861	23	0.32	0.64	√	√
3	kolo mee	515	14	0.30	0.66		√
4	nasi ayam	277	7	0.32	0.51	√	
5	satay	150	4	0.25	0.51	√	√
6	nasi lemak	148	4	0.26	0.46	√	√
7	midin	119	3	0.22	0.50		√
8	ayam penyet	101	3	0.32	0.51		√
9	roti canai	79	2	0.35	0.51		√
10	ngiu chap	61	2	0.29	0.56	√	√
11	mee jawa	60	2	0.32	0.56		√
12	kompia	60	2	0.19	0.51		√
13	umai	57	1	0.28	0.54		√
14	kampua	45	1	0.22	0.63		√
15	kek lapis	42	1	0.19	0.68		√
16	Soto	35	1	0.27	0.67	√	
17	gula apong	26	1	0.28	0.74		√
18	manok pansoh	26	1	0.28	0.72		√
19	beehoon	21	1	0.22	0.43		√
20	kueh chap	19	< 1	0.34	0.62		√
21	lalapan ayam	17	< 1	0.11	0.65		√
22	mee mamak	11	< 1	0.43	0.75		√
23	mee sua	10	< 1	0.12	0.60		√
24	fish soup	7	< 1	0.15	0.66		√
25	rice porridge	6	< 1	0.23	0.47		√
26	belacan beehoon	6	< 1	0.33	0.47		√
27	pisang goreng	5	< 1	0.22	0.60	√	
28	kedondong juice	5	< 1	0.05	0.52		√
29	fish balls	4	< 1	0.05	0.40		√
30	daun ubi	4	< 1	0.18	1.00		√
31	mixed pork soup	3	< 1	-0.03	0.60		√
32	bah kut teh	2	< 1	-0.05	0.80	√	
33	fish head curry	2	< 1	0.07	0.20	√	
34	nasi kuning	2	< 1	0.26	0.80	√	
35	kopi c	2	< 1	0.30	0.80		√
36	belacan midin	2	< 1	0.20	0.20		√
37	mee udang	2	< 1	0.35	1.00		√
38	roti arab	2	< 1	0.21	0.80		√
39	soya bean milk	1	< 1	0.25	1.00		√
		Total 3,811	**Total 100**	**Mean 0.23**	**Mean 0.61**	**Total 11/15**	**Total 33/43**

Overall, Sarawak restaurant food review sentences correlate with ST food promotion at r = 0.10 which is a weakly positive relation. This is far lower than for STB and is likely to be due to the greater number of foods promoted. And, if DMO promotion drives rather than simply reflects food choices, then this weaker correlation may be due to the comparatively unfocused food promotion on the ST website. As for the competing region's promotion, Sarawak food reviews correlate with STB food promotion at r = 0.02 which is essentially uncorrelated. So even though there is considerable overlap in the most popular foods, the greater number of foods for Sarawak cancels this out overall. The low correlation between Sarawak food reviews and both STB and ST food promotions can be considered a mixed result for ST. The correlations between DMO-promoted foods and relevant reviews on TripAdvisor are summarised in Table 6 below.

Table 6: Correlations between DMO food promotions and restaurant reviews for DMO-promoted foods by State

	TA Restaurant Reviews for DMO foods	
	Sabah Restaurants	**Sarawak Restaurants**
Sabah Tourism Foods	0.31	0.02
Sarawak Tourism Foods	0.02	0.20

Estimating DMOs Promotion Effectiveness

As discussed, the moderate positive correlation found between STB food promotions and Sabah reviews does not prove that the DMOs promotions drive the consumer behavior seen on TA. This cannot be established without a control group that has not been subject to the food promotions, which has never been formally done. However, some insight might be still found by analyzing differences in the foods chosen by locals and tourists. It is reasonable to assume that foreign tourists would be more exposed to DMO promotions than locals, with domestic tourists somewhere in between. If food choices by foreign tourists were found to be noticeably more in line with DMO promotions than locals then there is some evidence that the promotions are responsible. It is acknowledged that using locals as a control group is far from perfect since most locals differ significantly in knowledge and background from foreign tourists and are also far less likely to place reviews on TA. Nevertheless, some insight may be obtained.

To allow this kind of analysis, the origin of the reviewer for each review containing DMO foods was estimated, with results shown in Table 7. As might be expected, there are more total reviews by tourists but the proportion of multiple reviews by local reviewers is higher than that of the others due to extended access to local restaurants.

Table 7: Reviewer Origin for DMO-promoted food reviews on TripAdvisor

Origin	Reviews	Unique Reviewers
Sabah	720	295
Sarawak	1149	392
Domestic	2261	823
Foreign	2797	1425
Total	**6,926**	**2,935**

When broken down by reviewer origin (foreign, domestic, local), the Sabah restaurant results from the previous section are shown in Table 8 below. To simplify the presentation here, only the top 10 foods are listed although the results are similar for the remaining foods not shown. The first set of columns displays raw review counts for each food with obvious differences by reviewer origin. However, since there are fewer locals than other types, the middle set of columns shows these counts as a percentage of the total number of sentences for that reviewer type. When normalized this way, the differences in choices are less stark but there are some worth noting.

Locals review TA notably less seafood than both types of tourists and have a slightly less positive sentiment towards it. Although foreign tourists have the highest positive sentiment towards seafood, domestic tourists

choose it more. Perhaps this is because domestic tourists have become more aware of seafood through everyday Malaysian life (anecdotally, Sabah is known for seafood among Malaysians even though it is not considered a traditional Sabah dish). Locals eat more of the generically Malaysian *Nasi Ayam* but think less of it, perhaps reflecting everyday eating that domestic tourists may seek to avoid when on holiday.

But perhaps surprisingly, there are no decisive differences between the DMOs-promoted foods chosen by foreign tourists and by locals. The minor differences observed can be considered only weak evidence that STB food promotion drives food choices.

Table 8: TripAdvisor Reviews and Sentiment for Top 10 DMO promoted foods in Sabah by Reviewer Origin

	# reviews			% of reviews			Mean Sentiment		
	For.	**Dom.**	**Loc.**	**For.**	**Dom.**	**Loc.**	**For.**	**Dom.**	**Loc.**
seafood	873	689	399	63	68	56	0.39	0.34	0.30
nasi ayam	109	72	82	8	7	11	0.35	0.26	0.20
laksa	84	54	26	6	5	4	0.36	0.34	0.31
nasi lemak	47	27	46	3	3	6	0.28	0.25	0.17
satay	68	13	18	5	1	3	0.24	0.32	0.27
ngiu chap	22	24	32	2	2	4	0.41	0.39	0.3
fish soup	20	35	20	1	3	3	0.45	0.39	0.46
roti canai	47	12	14	3	1	2	0.44	0.29	0.47
bah kut teh	37	15	16	3	1	2	0.29	0.42	0.27
Soto	17	17	22	1	2	3	0.29	0.18	0.32
	1324	**958**	**675**	**96**	**94**	**94**	**0.35**	**0.32**	**0.31**

For Sarawak, the story is slightly different. A smaller proportion of local reviews are for foods in the top ten. Notably, the top 10 foods account for only 84% of local reviews versus 89% for foreign and 88% for domestic tourists. This indicates that more reviews by locals are about the less popular foods not chosen by domestic or foreign tourists. As in Sabah, seafood is less popular and less positively seen among locals, and this attitude also applies to the top 4 foods listed in Table 9.

Table 9: TripAdvisor Reviews and Sentiment for Top 10 DMO promoted foods in Sarawak by Reviewer Origin

	# reviews			% of reviews			Mean Sentiment		
	For	**Dom**	**Loc**	**For**	**Dom**	**Loc**	**For**	**Dom**	**Loc**
seafood	405	325	286	29	26	25	0.34	0.3	0.29
laksa	341	291	229	24	23	20	0.30	0.32	0.33
kolo mee	185	197	133	13	16	12	0.33	0.3	0.26
nasi ayam	85	79	113	6	6	10	0.35	0.31	0.29
satay	57	43	50	4	3	4	0.24	0.24	0.28
nasi lemak	66	46	36	5	4	3	0.24	0.31	0.23
midin	38	45	36	3	4	3	0.31	0.13	0.21
ayam penyet	30	33	38	2	3	3	0.32	0.25	0.4
roti canai	30	27	22	2	2	2	0.34	0.32	0.39
ngiu chap	28	6	27	2	< 1	2	0.25	0.3	0.31
	1265	**1092**	**970**	**89**	**88**	**84**	**0.30**	**0.28**	**0.30**

Findings provide slightly stronger evidence that food choices by foreign and domestic tourists are more in line with ST food promotion than those of locals. However, it is harder to reconcile this finding with the weak correlation found between reviews and ST promotion earlier and the less focused approach taken on the website.

5. Conclusions, Limitations and Future Work

The objective of this study was to use data mining techniques to determine the extent to which tourist food choices are in line with foods promoted by DMOs, and how distinct these choices are from a rival DMO's promotion. The specific dataset used was TripAdvisor restaurant reviews and the DMOs studied were STB and ST in Malaysian Borneo. Online foods promoted by DMOs were analyzed for each region and found to be highly distinctive with only five foods promoted by both. However, analysis of TA reviews showed that these commonly promoted foods were more popular in both regions than region-specific foods. In Sabah, common foods accounted for 33% of promotion and 85% of reviews for DMO foods. In Sarawak, common foods were 12% of promotion and 64% of reviews for DMO foods, showing that Sarawak had more reviews for region-specific foods than Sabah. Significantly different distributions of food choices were found for each region and some small but potentially useful differences in food choice and sentiment between tourists and locals were also identified. Aspect-based SA revealed several discrepancies between TA review sentences concerning specific food types and overall review ratings, leading to potentially actionable information to manage food branding. Notably, the DMOs promoted foods did not include most of the indigenous dishes of Sabah or Sarawak. As such, it is essential that both popular local cuisines and indigenous dishes should be competently incorporated into destination marketing efforts with specific presence on DMO websites, and with 'places to eat' icons listed by district, suburbs, or streets in the city. Social media influencers such as bloggers and vloggers should remain as active ambassadors for DMOs as tourists continue to trust UGC. Moreover, there are plenty of local dishes that remain uncited in the literature and were not covered in this analysis. Food must be seen as a vital component of marketing efforts because local foods do impact visitors' perceived image of the destination. Notably, in 2021, Kuching in Sarawak gained the accolade of City of Gastronomy under the UNESCO Creative Cities Network and this will enhance its destination brand by linking farm to fork. Sabah is encouraged to consider food for thought as a supplementary destination image.

This study provides valuable insights into the distinction between projected and perceived images (Költringer & Dickinger, 2015; Lai et al., 2017) which might enhance food destination branding using data mining methods and SA for DMOs (Filho, 2020; Franzoni & Bonera, 2019). Findings contribute to the literature indicating support that local foods are used to form the destination brand in both regional DMOs and support destination marketing (Ellis et al., 2018; Choe & Kim, 2018; Björk & Kauppinen-Räisänen, 2016). However, findings also support the contention by Okumus et al. (2018) that local cuisines have not been skilfully integrated into the marketing efforts. For example, dishes are being promoted by DMOs that receive low or no reviews on TA. Findings also present a system with which DMOs can utilize data mining methods to integrate food into tourism marketing and SA to improve destination branding. Application of this data mining system would support suggestions by Filho (2020) and Franzoni and Bonera (2019) ensuring SA as projected by TA reviews is utilized for regional differentiation which could indeed uplift local gastronomy for destination marketing. Findings also support the work by Yu and Zhang (2020) that knowledge of customer feelings towards gastronomy is an important aspect of the dining experience. In this study, the novel system generates vital information for destination branding as it provides indications of reviews and sentiments for foreign and domestic tourists as well as locals based on UGC from TA.

The findings presented here are only early work but provide some level of insight that DMOs may find useful in monitoring their promotions and those of the competition. Both regions had some encouraging results and some areas to address. There are obvious limitations in using TA for business intelligence compared to commissioning a dedicated study. However, the data is free and requires little work if automation techniques from data mining are used. As stated earlier, a more comprehensive determination of foods in all region restaurant reviews would be an advantage but such an open-ended task is highly challenging for current Natural Language Processing and was beyond the scope of this current project. This will be addressed in future work. Also, the system developed here will be extended to process reviews in languages other than English. On

TripAdvisor, there are significant numbers of regional restaurant reviews in Malay and Mandarin which may modify the conclusions drawn here.

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