The Relationship between Weather and Meal choices: A Case Study of Restaurants and Cafés on Korean University Campus

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Content

ABSTRACT

The food service industry is a major driver of global sustainable food consumption. By understanding food consumption behavior, restaurant managers can forecast demands and reduce pre-consumer food waste. This study investigates the relationship between influencing factors and the number of customers at restaurants and cafés. These factors are weather-related factors, including rain and temperature, and school-related factors, including exams and the day of the week. Based on these four factors, 24 possible combinations were created. Three representtive days were chosen for each weekday combination. Besides, one representative day was chosen for each weekend combination. In total, 48 days were sampled throughout the year. Customer data were collected from six restaurants and cafes on a Korean university campus. Conjoint analysis was used to determine the relative importance of each variable to customer numbers. Following that, utility scores were standardized and mapped to determine the best condition when the number of customers was at its peak. In addition, each store's sales were compared using Pearson's Correlation Coefficient. The findings support that temperature and rain influences are correlated with the number of customers. Furthermore, we discovered that temperature was far more significant than rain in determining the number of customers. The paper discusses the implications of weather to forecast food and beverage demand and predict meal choices.

Keywords: Food Consumption Behavior, Food Service Industry, Weather, Demand Forecast, Purchasing Behavior

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1. Introduction

The food service sector refers to the industry that provides serviced supply of food and beverages prepared and served away from home (Davis et al., 2018). The global foodservice market accounts for 40% of the global food and agriculture industry (IMARC, 2021). With the prevalence of out-of-home dining, the food service sector is critical in driving sustainable food consumption.

Globally, one-third of food produced is wasted or lost yearly (Gustavsson et al., 2011). The significance of food waste is demonstrated in the United Nations Sustainable Development Goal 12, 'Responsible Consumption and Production,' which aims to reduce global food waste and food loss along the production and supply chain by half by 2030 (United Nations, 2016). Although food waste may occur during any stage of the supply chain, in industrialized countries, more than 40 percent of losses happen at retail and consumer levels (FAO, 2016). More specifically, a case study of 10 restaurants in London showed that 65 percent of food waste in restaurants is from preparation, 30 percent comes back from the customer's plate, and 5 percent is spoilage (Sustainable Restaurant Association, 2010). Despite significant economic, social, and environmental impacts (Lins et al., 2021), food waste in the food service industry remains an unsolved wicked problem.

Reducing food waste occurring in the preparation stage holds the most promise. Among the relevant intervention strategies, a study has shown that demand forecasting could help restaurants ensure minimal food waste due to overstocking of food materials and maximizing restaurants' profits (Posch et al., 2022).

This research aims to have a clearer understanding of what factors influence the consumption of particular food. Through this, it is expected that restaurants and cafes could predict their sales and plan their stock and marketing strategies accordingly.

2. Literature Review

2.1 Weather and consumer behaviors

The effect of weather on human behaviors has been widely studied. The weather has been proven to affect mood (Howarth and Hoffman, 1984), productivity (Deryugina and Hsiang, 2014), and even stock prices (Akhtari, 2011). Many studies have found the importance of using weather to predict and anticipate trends (Markowitz, 2011). The weather has been shown to affect customer spending (Deryugina and Hsiang, 2014) and has long been recognized as a strategic element in demand chain planning (Cawthorn, 1998). Many retail stores use these insights to manage their logistics of retail products (Starr-McCluer, 2000; Edwards, 2012). A study has also investigated the association between weather and daily shopping patterns (Parsons, 2001). Similarly, another research is conducted to determine the influences of weather on sales based on real-world daily sales, targeting a family restaurant company and an outdoor fashion company. Their results show that the impact of weather on store sales depends on their regional and location characteristics when it rains (Chu et al., 2013).

2.2 Weather and food consumption

The effect of weather and the consumption behavior of food has also been investigated. It has been found that daily caloric intake is higher in fall compared to spring, and people consume most carbohydrates in spring and most fat in fall (Ma et al., 2006). It is also suggested that the ecological and evolutionary explanation of the increased food intake in fall is to prepare for winter when food is scared (De Castro, 1991). However, Ma and colleagues conclude that the magnitude of change in the seasonal diet variation is relatively small. Another research shows that the troops consumed greater calories of food in the Arctic compared to the desert, which cannot be explained by the increase in metabolic rate alone (Johnson and Kark, 1947).

Additionally, research shows that weather affects the sales of certain food items such as soft drinks, hot chocolate, or strawberries. Supermarkets such as TESCO have researched for more than 15 years to use the weather forecast to predict what kind of food to stock (Cohen, 2011). The results show that by the time of the first weekend of winter, as it turns bitterly cold, hot chocolates are flying off the shelves, whereas, on the first hot weekend, we can see strawberry sales increase by 20 percent. The report also mentions that ‘there is a 4.5 percent weather impact on food sales, and 6 percent for clothing, which can make a difference to profit and loss.’ Besides, research has shown the significant impact of seasonal factors, which consist of temperature and week-in-year factors, on the sales of soft drinks in the UK (Ramanathan and Muyldermans, 2010).

Nonetheless, studies that prove the correlation between weather conditions and food consumption behavior are scarce. Moreover, the complex characteristics of each restaurant and café make it challenging to make predictions based on previous studies, especially regarding drinks and fast food. The effect of weather on sales of particular food items can not directly predict food sales with many variations. Therefore, we selected the university campus as a case study to explore the association between weather and school factors, and meal choices. The hypothesis is that weather and school factors influence meal choice.

3. Method

3.1 Preliminary study

While weather conditions consist of several elements, including temperature, precipitation, humidity, cloud cover, wind, and air pressure, the temperature is the most determinant of weather, as all other elements depend on it. Based on the literature review, the rain factor also greatly influences behavior besides temperature. To determine whether other factors may affect the number of customers other than weather, we conducted preliminary observations on a Korean university campus, which was selected as a case study. We observed stores were more crowded on weekdays, while on weekends, certain places were occupied by some visitors to some extent. Moreover, exams may have influenced students’ eating habits because of a busier schedule or stress. Therefore, we added two more factors:

'the day of a week' (weekday or weekend) and 'exam' (exam period or no-exam period). Thus, the independent variables are temperature, rain, exam, and the day of a week, whereas the dependent variable is the number of customers.

3.2 Study design

To limit the scope of the study, only the number of customers during the semester was investigated. To create different combinations, we specified four factors with corresponding levels. The first factor is the 'temperature' of the weather, consisting of three levels: hot (~35 ° C), warm (~20° C), and cold (~0° C). The temperature levels were specified based on the highest temperature of the day. The second factor is 'rain,' consisting of two levels: a day with rain and day without rain. The rainy days were selected based on the highest precipitation level. The third factor is 'exam,' consisting of two levels: exam period and no exam period. The exam period was defined as two weeks, starting from the Saturday before the official exam week until the Friday of the official exam week. Lastly, the fourth factor is 'the day of a week,' consisting of two levels: weekday and weekend.

Based on these four factors, 24 different cases were created. From the weather report, three representative days were randomly selected for each case. However, only one representative day was selected for weekend cases since there were much less available data that fit into the defined conditions on weekends compared to weekdays. Also, the official Korean holidays were avoided since there were much fewer students on campus. Therefore, the number of selected days in total

Tab. 3-1 Data sampling

Factors				Dates		
Weekday	Exam	Rain	Hot	6/11	6/12	6/18
			Warm	4/13	4/16	4/20
			Cold	12/11	12/16	4/14
		No Rain	Hot	6/10	6/15	6/19
			Warm	4/21	4/22	4/23
			Cold	12/8	12/12	12/17
	No Exam	Rain	Hot	9/1	9/3	9/11
			Warm	4/2	4/29	5/12
			Cold	11/28	12/3	3/3
		No Rain	Hot	5/28	6/4	8/31
			Warm	5/4	5/13	5/22
			Cold	12/2	12/5	3/10
Weekend	Exam	Rain	Hot	6/13		
			Warm	6/14		
			Cold	4/19		
		No Rain	Hot	6/7		
			Warm	4/12		
			Cold	12/7		
	No Exam	Rain	Hot	9/6		
			Warm	5/3		
			Cold	11/30		
		No Rain	Hot	5/31		
			Warm	4/4		
			Cold	3/7		

Tab. 3-2 Restaurants and cafés

Stores	Types of Food & Drink	Operating Hours
S1	Donuts & Drinks	Mon ~ Sun 7AM~11PM
S2	Smoothies & Coffee	Mon ~ Sun 7AM~11PM
S3	Burgers, Fries & Soft drinks	Mon ~ Sun 9AM~12AM
S4	Instant Noodles	Mon ~ FRI 2PM~4PM
S5	Drinks & Sandwiches	Mon ~ FRI 8:30AM~8PM
S6	Burritos, Sandwiches & Juices	Mon ~ FRI 11AM~7PM (Break 2PM~4PM)

was 48 days, including 36 weekdays and 12 weekends <Table 3-1>. For two stores, S4 and S5, 'the day of a week' factor was eliminated since they do not operate during the weekend. Thus, there were only 12 combinations in total for these two stores. For store S6, they did not operate during the weekend as well, and because they recently opened, there were no cold days since the opening. The 'cold' level was eliminated from the temperature factor; therefore, there were only 8 combinations for store S6.

3.3 Data collection

Two types of data were collected. One is the independent variables, including 'weather' factors and 'school' factors. The other is dependent variable, which is the number of customers.

Independent Variables: the weather data from accuweather.com during one year were collected. Each day, information regarding the highest temperature, and the precipitation level was extracted. The information was collected from the university academic calendar, whether the day was in the exam or the no-exam period.

Dependent Variables: Based on the selected dates, we asked the restaurants and cafes to provide us with the numbers of customers, which were estimated by the receipts. Six restaurants and cafés inside the campus agreed to participate in the study. The type of food they serve and the operating hours of each restaurant and café can be seen in <Table 3-2>.

Once all data was collected, the conjoint analysis for each restaurant and cafés was performed using IBM SPSS Statistics.

4. Results

Based on the conjoint analysis, each variable's relative importance on customers' numbers is examined. The importance summary of each factor

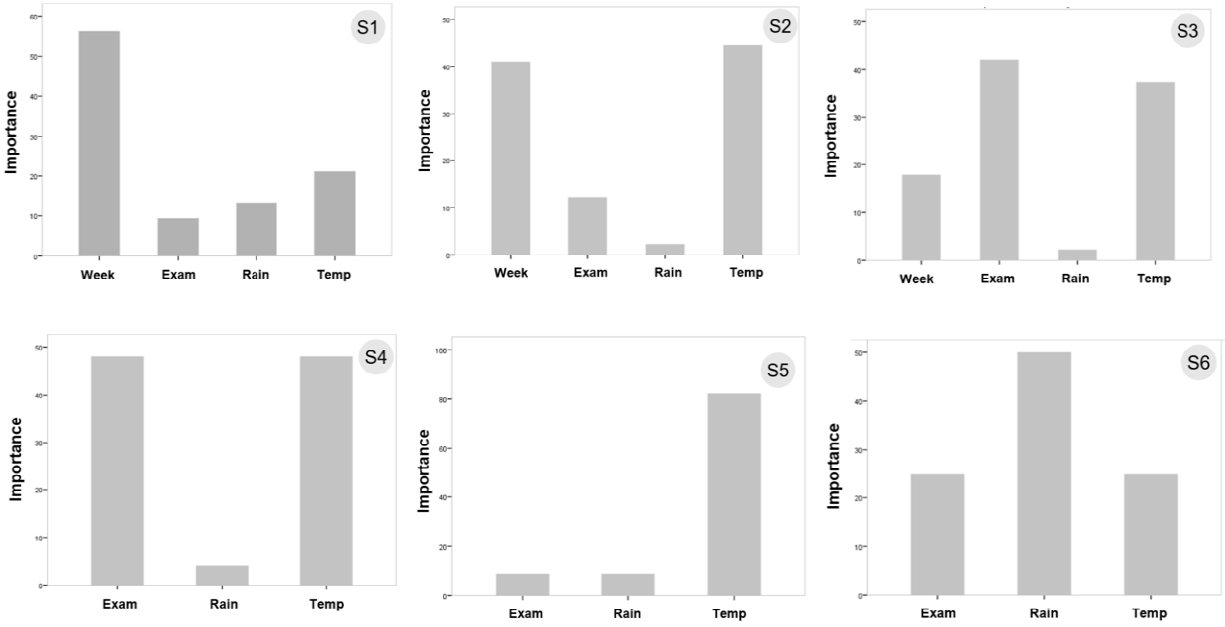


Fig. 4-1 Importance Summaries

for each restaurant and café is as follows <Fig. 4-1>.

S1 sales were highly influenced by the day of a week factor, followed by temperature, rain, and exam factors. S2's sales were almost equally influenced by the day of a week and temperature factors, followed by exam factors, and very little influenced by rain. S3's sales were similarly influenced by the exam and the temperature factors, followed by the day of a week factors, and very little influenced by rain. S4's sales were nearly equally influenced by exam and temperature factors and very little influenced by rain. S5's sales were mainly influenced by temperature and little influenced by exam and rain factors. Lastly, S6's sales were highly influenced by the rain factor, followed equally by the exam and temperature factors.

The correlation of four factors and the number of customers is significant at 0.03 level for S4 and 0.00 level for the other five analyses. Overall, four out of six stores scored over 35 percent on the importance of temperature factor, one out of six stores scored over 45 percent, and two out of six stores scored from 10~20 percent on the importance of rain factor.

The utility score showed the best condition in which the number of customers is the highest. We standardized the utility score and mapped them into x-y coordinates: one with 'weather-related' factors <Fig. 4-2> and the other with school-related factors <Fig. 4-3>. For S1, customers increased on warm days, days without rain, and weekdays. For S2, customers increased significantly on hot days, increased fairly on rainy days and during the exam period, and increased greatly on weekdays. For S3, customers increased on days without rain and during hot and warm temperatures, increased on weekends, and increased greatly during the exam period. For S4, customers increased slightly when it rains, increased greatly on cold days, and increased greatly during the exam period. For S5, customers

Tab. 4-1. Pearson's correlation coefficient of five stores

		S1	S2	S3	S4	S5
S1	Pearson Correlation	1	.750**	-0.038	-0.228	-0.096
	Sig. (2-tailed)		0	0.816	0.158	0.554
	N	40	40	40	40	40
S2	Pearson Correlation	.750**	1	.323*	-0.248	0.149
	Sig. (2-tailed)	0		0.042	0.123	0.357
	N	40	40	40	40	40
S3	Pearson Correlation	-0.038	.323*	1	.314*	.362*
	Sig. (2-tailed)	0.816	0.042		0.049	0.022
	N	40	40	40	40	40
S4	Pearson Correlation	-0.228	-0.248	.314*	1	-0.248
	Sig. (2-tailed)	0.158	0.123	0.049		0.123
	N	40	40	40	40	40
S5	Pearson Correlation	-0.096	0.149	.362*	-0.248	1
	Sig. (2-tailed)	0.544	0.357	0.022	0.123	
	N	40	40	40	40	40

*. Correlation is significant at the 0.05 level (2-tailed), **. Correlation is significant at the 0.01 level (2-tailed)

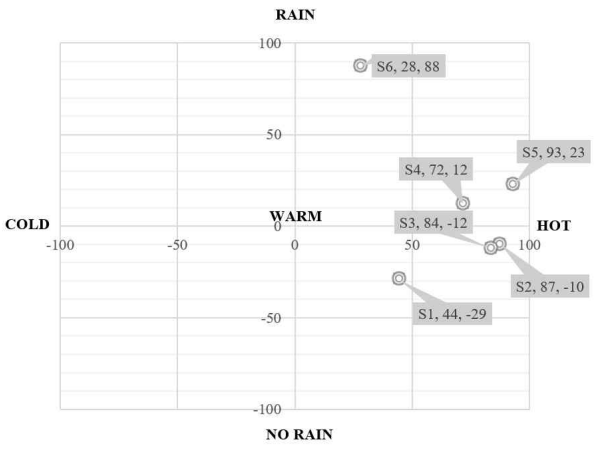
increased greatly on hot days, increased slightly on rainy days, and increased slightly during the exam period. Lastly, for S6, customers increased greatly with rain, and fairly with hot temperatures and during the exam period.

In addition, we conducted a correlation analysis of the number of customers among five out of six restaurants and cafés during the 36 weekdays. S6 was eliminated because the data contained a different set of dates from the other five stores. The result showed that S1 sales and S2 sales were highly correlated at 0.01 level <Table 4-1>.

5. Discussion

We could see that S1 and S2 sold better on weekdays, while S3 sold better on weekends. The reason could be that S1 and S2 stores are surrounded by several big departments, where students go to laboratories or attend classes. Also, during the weekend, S3 is the perfect option for students who wake up late, and whose schedules may not match the cafeteria's regular operating hours. Thus, they tend to have meals at S3 instead. In all stores, sales increased during the exam period. This could be because people need more energy during the exam or do not go to eat or drink outside the campus. Most stores, excluding S4, sold better during hot days. Perhaps, because they primarily serve cold drinks. It could also be because people tend to move less during winter, leading to fewer sales. As expected, people tended to consume noodle soups more during cold weather. In addition, rainy days might have prevented people from going outside the building, making the sales for S1, located on the far side of the campus, slightly decrease. However, in most stores, sales increased on rainy days. Perhaps, it was more difficult to go outside campus. Another reason could be that rain makes people depressed and eat more. Lastly, students visited S3 equally, whether it rained or not. This could be due to the location that is in proximity to students' dormitories.

From the correlation analysis <Table 4-1>, S1 and S2 are the most correlated pairs. We hypothesized that their sales are highly correlated



Fig, 4-2 Utility score mapping between weather-related factors

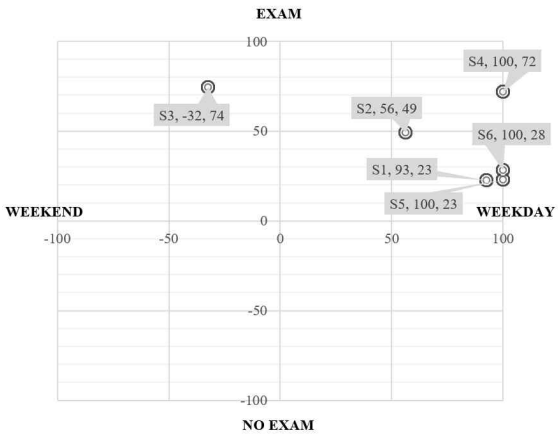


Fig. 4-3 Utility score mapping between school-related factors

due to their similar characteristics; both are located inside the department's building, surrounded by several big departments. Other highly correlated pairs are S3 and S4. We can see that they sell similar types of food, which is fast food. If we examine the importance summary of both stores, they have a similar tendency- greatly influenced by exam and temperature factors. The result suggests that besides the effect of weather, the location of the stores can also be influential and worth investigating further.

The results showed a significant effect of temperature and rain on the number of customers and revealed the possible implications of using weather to predict sales, making the study worth further investigation. For example, S4 can forecast that there will be more customers on cold rainy days, so they can prepare more staff members in advance to sell even more. Also, <Fig. 4-2> shows the less saturated area, such as on cold days, which opens a significant opportunity for restaurants and cafés to serve products or services in this weather condition. For potential implications, restaurant managers can use these results to predict the number of customers to reduce food waste by preparing food ingredients more or less. Also, they can manage to assign more part-time staff on days with predicted higher volume and vice versa, allowing them to better utilize resources. In addition, managers can plan marketing and advertising campaign to boost the sales of specific products that people may crave more during certain weather conditions.

6. Conclusion

To summarize, this paper investigates the relationship between weather & school-related factors and the number of customers based on the data collected from six restaurants inside a Korean university campus. The conjoint analysis shows that the effect of weather on the number of customers is significant in all six stores. Among the two weather factors, temperature shows much greater importance in the number of customers than rain. Based on our analysis, the types of food and location of the stores could be the influential characteristics behind weather sensitivity.

In Korea, there is a popular saying that the perfect food for rainy days is a fried pancake and rice wine. However, there is a scarcity of scientific evidence to support this concept. Although we did not specifically investigate a desire for a specific food item, this study provided additional insights into possible weather-related food cravings.

There are some limitations of this study that are beyond our control. Daily menu variations, new menu launches, special occasions such as Christmas, or promotion deals may affect sales. Organized events using catering services may increase sales abruptly and do not represent the whole population's behaviors. Moreover, when the number of customers reaches its peak, the waiting time may affect potential customers' choices. Thus, there could be a ceiling effect. These are influences that are difficult to avoid.

However, some limitations could be improved in future studies. Firstly, regarding the weather conditions, we only included the highest temperature and the day's precipitation for the simplicity of the analysis. However, other weather conditions may have had more significant influences on the number of customers, such as the perceived temperature, humidity level, amount of sunshine, or wind intensity. Secondly, we could have included restaurants and cafés with similar characteristics for

comparison. Moreover, it would be better if we could have exhaustively surveyed every other on-campus restaurant and cafés. Lastly, for a more comprehensive study, we could collect the number of sales of each particular type of food item instead of collecting an overall number of customers. For example, at a donut store, we can collect whether a customer consumes donuts or drinks, hot drinks or cold drinks, coffee, or non-coffee drinks

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날씨와 식사 선택의 관계: 한국대학 캠퍼스 내 식당과 카페의 사례연구

담잠랏시 뿐요타이* · 이용기**

요약

외식서비스산업은 지속가능한 세계 식품 소비의 주요 원동력이다. 외식소비행동을 이해함으로써, 식당 관리자들은 수요를 예측하고 소비 전(前)단계에서 음식 낭비를 줄일 수 있다. 본 연구는 식당과 카페의 영향 요인과 고객 수 간의 관계를 조사한다. 이러한 요인들은 비와 기온을 포함한 날씨와 관련된 요인들과 시험 기간과 요일을 포함한 학교 관련 요인들이다. 이 네 가지 요인에 기초하여 가능한 조합은 24개였다. 각 평일 조합에 대해서는 3가지 요일을 대표일로 정하였다. 각 주말 조합에 대해서는 1가지 요일을 대표일로 정하였다. 일 년 중 총 48일이 표본으로 추출되었다. 고객 자료는 한국의 한 대학 캠퍼스에 있는 6개의 식당과 카페에서 수집되었다. 고객 수에 대한 각 변수의 상대적 중요도를 결정하기 위해 컨조인트 분석(Conjoint Analysis)이 사용되었다. 이어 효용 값 (Utility Score)를 표준화하여 고객 수가 최고점에 도달했을 때 최적의 상태를 찾도록 매핑 (Mapping) 하였다. 또한 피어슨 상관 계수(Pearson's Correlation Coefficient)를 사용하여 각 점포의 매출을 비교하였다. 본 연구 결과는 온도와 비의 영향이 고객 수와 상관관계가 있다는 것을 뒷받침하였다. 또한, 고객 수를 예측하는 데 있어서 온도가 비보다 훨씬 더 중요하다는 것이 발견되었다. 본 논문은 식음료 수요를 예측하고 식사 선택을 예측하기 위해 날씨를 사용하는 것의 시사점에 대해 논의하였다.

키워드: 외식 소비 행동, 외식 서비스 산업, 날씨, 수요 예측, 구매 행동

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