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A Review of Forecasting Studies for the Restaurant Industry: Focusing on results, contributions and limitations

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A B S T R A C T

Purpose: The purpose of this study is to explore restaurant forecasting studies through a comprehensive review of existing studies, discuss the contributions and limitations of those studies and uncover possible directions for future research.
Design/methodology/approach: Key restaurant forecasting studies were collected by searching keywords in Google Scholar and selected based on their citation times. A final pool of 29 key studies in the restaurant field was analyzed and discussed.
Findings: According to this study, most forecasting studies have focused on model building and its accuracy. These studies used combined and hybrid models more frequently than single qualitative or quantitative models and focused on sales volume. By calculating citation counts and average citation times per year, this study ranked articles published to show their impact on the body of knowledge in this field. In addition, by reviewing the affiliations of the first authors of these studies, this paper found that the United States has been publishing the earliest and most papers related to forecasting in the restaurant industry.
Research limitations/implications: This study used the citation count to measure the impact of a study. While this serves the purpose of this study, citation counts may not perfectly represent the value and impact of a study. The findings of this study provide a guide post for future studies.
Originality/value: This study provides an updated, comprehensive literature review of the overall development, contributions and limitations of forecasting studies in the restaurant field. The researchers can see the subjects and types of research that have already been conducted and which topics remain unexamined.

Keywords: Restaurant industry, Forecasting, Literature review, Contributions, Limitations

I. Introduction

Businesses in every industry have to overcome the negative effects of seasonality, changing demand levels, price-cutting maneuvers of the competition, and even large swings in the economy. Forecasting is a decision-making tool that helps companies to overcome these negative effects and cope with the uncertainty that comes with these changes and fluctuations (Chambers et al., 1971). It is especially important in the restaurant industry due to the perishability of the product (Kimes et al., 1998; Messersmith & Miller, 1991). Once a meal is produced, it should be consumed. Forecasting

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could help restaurants allocate resources properly and have an effect on using resources (Green & Weaver, 2008). Reynolds et al. (2013) suggest that forecasting the expected sales growth of restaurants will help operators in planning, constructing facilities, hiring employees, and developing other related assets, thereby ensuring corresponding service, revenue, and competitive advantage growth. Forecasting is an estimation of an actual value of a future period or another situation (Otudi & Almaktoom, 2021). It is vital to businesses since it contributes to better cost control, productivity increase, and profit maximization (Green & Weaver, 2008).

In view of the importance of accurate forecasting of dynamic and complex tourism markets, several hundreds of studies have been published over the past decades with a particular focus on tourism demand model construction and performance evaluation. Some researchers have conducted systematic reviews of tourism forecasting literature (Ghalehkhondabi et al., 2019; Jiao & Chen, 2019; Kim et al., 2018; Li & Wu, 2019; Li et al., 2021; Song et al., 2019; Witt & Witt, 1995). For example, Song et al. (2019) reviewed the current literature from 2007 to 2017 in the field of tourism and passenger transportation demand forecasting and studied and categorized this based on the forecasting method used. A study conducted by Kim et al. (2018) comprehensively presented a taxonomy of 171 review studies published in major hospitality and tourism journals listed in the Web of Science and examined the impacts that the review studies made in the literature. The most recent study by Jiao and Chen (2019) conducted an organized review of method development in tourism demand forecasting areas, particularly focusing on AI and combination forecasts in tourism demand forecasting, which were two relatively new types of methods. Another study done by Liu et al. (2019) traced the development of tourism forecasting research by using quantitative bibliometric techniques. These researchers have illustrated a broad view of tourism academia, but most of them have only focused on finding publication trends and comparing research methods by quantitative bibliometric techniques in scholarly tourism journals.

Although the benefits of accurate forecasts for tourism, hotels, and restaurant companies are obvious, the previous literature only reviewed the forecasting studies of the tourism industry, and these were mainly about methodology itself, and they did not discuss their findings, contributions or limitations. There is literally no comprehensive review regarding the overall development, contributions and limitations of forecasting studies in the restaurant field. Reviewing their findings, contributions and the shortfall of their studies is very important because future studies can get guidelines to fill these gaps. This study started to fill the gap that has not been filled so far. More specifically, the main purposes of this study are: 1) to explore restaurant forecasting studies through a comprehensive review of existing studies; 2) to discuss the developments, contributions and limitations of these studies classified into five subject areas; and 3) to uncover possible directions for future research. The results of this study are expected to enrich research on restaurant forecasting, thereby providing more perspectives for scholars and restaurant operators. This study will contribute to the current forecasting literature through a comprehensive overview of the overall development, contributions, and limitations of forecasting studies in the restaurant field. The results of this study will help researchers to see the subjects and types of research that had already been conducted and which topics remain unexamined.

II. Methodology

A. Key Literature Selection

In order to achieve the purpose of this study, it was necessary to adopt a systematic literature review method to ensure the rigor and transparency of the review process. The data collection process of this study consisted of the following three steps.

The first step was a large-scale keyword search for restaurant forecasting studies from main academic databases. The most common method of data collection

for reviewing papers is keyword searching (Kim et al., 2018). In this paper, terms such as "forecast" and "restaurant" were used in keyword searches for forecasting research on Google Scholar. This basic search process resulted in the retrieval of 15,100 studies in the restaurant field.

The second step was a manual check of all studies to select key literature. First, this study selected those papers that were highly relevant to restaurant forecasting. Keywords such as forecast, restaurant, etc., appear only in the text, but thesis topics that did not meet our subject were excluded. Second, papers in the field of socioeconomics were selected, whereas those related to other fields (such as engineering and politics) were excluded. Moreover, books and conference materials with only chapters relevant to restaurant forecasting were excluded. Finally, 75 papers were selected through this process. These papers were published from 1976 to 2021. For each research paper, this study calculated the citation counts and their mean values. Citation counts refer to the total number of times one article was cited via the search engine. It has been noted as one of the most important indicators in evaluating the quality of academic research and is considered an indication of the influence of a study (Kim et al., 2018). To evaluate the overall impact of the individual studies, this study selected papers that received more citations than the average value, which is 29 for all studies. In addition, it is worth noting that this study also added all of the articles published after 2016, although some of them haven't been cited at all so far. The citation counts of these articles are generally low because they have been published recently. In order to consider the average impact of each paper per year, this study calculated the average citations per year. By this standard, we selected a pool of 35 studies in the restaurant field.

The final step was a cross-checking of the selected studies to ensure the rigor of the first two steps. After cross-checking the results of the studies, deleting publications where authors didn't comment on practical implications, limitations, and planned studies, a final pool of key literature in the restaurant field (29 studies) was determined. Specific information on the 29 key studies is summarized in Table 1.

Table 1. Summary of 29 key forecasting studies on restaurant industry

Author	Title	Subject area	Year	Citation Times	Average citations per year	Nation
Miller, McCahon, & Bloss	Food production forecasting with simple time series models	food production	1990	37	1.19	USA
Miller, McCahon, & Miller	Foodservice forecasting using simple mathematical models	covers	1991	30	1.00	USA
Cranage & Andrew	A comparison of time series and econometric models for forecasting restaurant sales	sales	1992	36	1.24	USA
Forst	Forecasting restaurant sales using multiple regression and Box-Jenkins analysis	sales	1992	31	1.07	USA
Liu, Bhattacharyya, Sclove, Chen, & Lattyak	Data mining on time series: an illustration using fast-food restaurant franchise data	sales	2001	120	6.00	USA
Ryu & Sanchez	The evaluation of forecasting methods at an institutional foodservice dining facility	demand	2003	42	2.33	USA
Hu, Chen, & McCain	Forecasting in short-term planning and management for a casino buffet restaurant	demand	2004	47	2.76	USA
Choi	Developing restaurant industry business cycle model and analyzing industry turning point	business cycle	2007	13	0.93	Korea
Youn & Gu	Predicting U.S. restaurant firm failures: The artificial neural network model versus logistic regression model	firm failure	2010	62	5.64	USA

Table 1. Continued

Author	Title	Subject area	Year	Citation Times	Average citations per year	Nation
Lee & Ha	Exploring the impacts of key economic indicators and economic recessions in the restaurant industry	sales	2012	34	3.78	USA
Kim & Upneja	Predicting restaurant financial distress using decision tree and AdaBoosted decision tree models	financial distress	2014	141	20.14	Korea
Davis, Rogers, & Huang	A survey of recent developments in queue wait time forecasting methods	queue wait time	2016	8	1.60	USA
Padgett, DeVincenzo, Munn, & Rajagopalan	Building Forecasting Models for Restaurant Owners and Managers: A Case Study.	numbers of visitors	2016	3	0.60	USA
Hidayatullah & Yudoko	Demand forecasting analysis using time series methods at Ayam Lodho Pak Yusuf restaurant	demand	2016	1	0.20	Indonesia
Takeyasu & Tatebayashi	A Hybrid Method to Improve Forecasting Accuracy In the Case of Japanese Food Restaurant	sales	2016	0	0.00	Japan
Versluis	Daily sales forecasting in foodservice: developing a model for application in an expert system	sales	2016	0	0.00	South Africa
Xinliang & Dandan	University restaurant sales forecast based on BP neural network-In Shanghai Jiao Tong University case	sales	2017	6	1.50	China
Meneghini, Anzanello, Kahmann, & Tortorella	Quantitative demand forecasting adjustment based on qualitative factors: case study at a fast food restaurant	demand	2018	8	2.67	Brazil
Ma, Tian, Luo, & Zhang	Predicting future visitors of restaurants using big data	numbers of visitors	2018	8	2.67	China
Zhang & Luo	Can user-posted photos serve as a leading indicator of restaurant survival? Evidence from Yelp	indicators	2018	7	2.33	USA
Boomija, Anandaraj, Nandhini, & Lavanya	Restaurant visitor time series forecasting using autoregressive integrated moving average	visitors	2018	1	0.33	India
Tanizaki, Hoshino, Shimmura, & Takenaka	Demand forecasting in restaurants using machine learning and statistical analysis	demand	2019	24	12.00	Japan
Ganesan, Divi, Moudhgalya, Sriharsha, & Vijayaraghavan	Forecasting food sales in a multiplex using dynamic artificial neural networks	sales	2019	4	2.00	India
Puspita, Primadani, & Susanti	Application of Material Requirement Planning with ARIMA Forecasting and Fixed Order Quantity Method in Optimizing the Inventory Policy of Raw Materials of Sederhana Restaurant in Palembang	demand	2020	1	1.00	Indonesia
Tanizaki, Hoshino, Shimmura, & Takenaka	Restaurants store management based on demand forecasting	demand	2020	0	0.00	Japan
Posch, Truden, Hungerländer, & Pilz	A Bayesian approach for predicting food and beverage sales in staff canteens and restaurants	sales	2021	2	2.00	Austria
Love	Forecasting Accurate Customer Counts in the Quick Service Restaurant Industry	visitors	2021	0	0.00	USA
Zháo & Jayadi	Forecasting Daily Visitors and Menu Demands in an Indonesian Chain Restaurant using Support Vector Regression Machine	demand	2021	0	0.00	Indonesia
Otudi & Almaktoom	THE IMPACT OF FORECASTING METHODS ON DEMAND PROJECTION IN FAST FOOD RESTAURANT	demand	2021	0	0.00	Saudi Arabia

B. Classifying Literature and Reviewing Process

To obtain a more targeted focus, the selected studies were classified into five categories. Among 29 articles, nine focused on demand, nine on sales, four on numbers of visitors, three on company operating status, and four on restaurant production and business cycle. Most of the forecasting studies in the restaurant industry focused on demand and sales. Demand in the restaurant environment can be measured by the sales of a particular menu or by guest counts. Sales refer to the revenue generated from the sale of food and beverages in a restaurant. Operating a restaurant comes with various inventory costs and ongoing expenses. In restaurants, forecasting sales helps with inventory management and overall budgeting. Visitors are the total number of guests who spend at a restaurant on a given day or period. Predicting how many future visitors there are could help restaurants to efficiently buy ingredients and schedule staff on a daily basis. Company operating status includes firm failure, financial distress, and the indicators in this study. And cyclical trends of the industry are about food production, future wait time values, and covers in a commercial foodservice environment. The selected articles were examined based on their forecasting domains, chronological order, the contribution of each publication as measured by citation score, frequency of applying methodology or approaches, demographic characteristics of authors, and key trends in forecasting research. The next section focuses on reviewing the contributions and limitations of these research works.

III. Restaurant Industry Forecasting

A. Studies on Forecasting Demand

A study by Ryu and Sanchez (2003) identified the most appropriate method of forecasting meal counts for an institutional food service facility at Texas Tech University. This research has been referenced 42 times. The results of this study revealed that multiple regression is the most accurate forecasting approach; however, because of its simplicity and high degree of accuracy, the naïve method was recognized as the most suitable forecasting method. However, the conclusions of this study may not apply to other restaurant types or settings because the examination was for a specific dining facility. The authors mentioned that restaurant managers should use suitable quantitative approaches, such as naïve methodologies with acceptable judgment, common sense, and experience, to improve forecast accuracy. Hu, Chen, and McCain (2004) examined eight forecasting models, six univariate time series models, and two multivariate regression models. The results of the study showed that a double moving average model was the most accurate model. According to the authors, this study was the first research to look at casino buffet restaurants. Future research should take combined forecast methods (with multiple forecasting methods) into consideration and compare forecasting performance to other simpler time series methods. Moreover, the independent variables in this study were derived from in-depth interviews with several casino operations analysts and financial analysts, and other factors affecting guest counts need to be examined in future studies. Future research could also replicate this research with other types of restaurants. This study has been cited for 47 times. Hidayatullah and Yudoko (2016) attempted to predict a restaurant's daily demand and reported that simple exponential smoothing was shown to be beneficial in forecasting demand. This research has only been cited once so far.

On the other hand, Meneghini et al. (2018) suggested a way of predicting demand that blends quantitative models with qualitative contextual factors, and their article has been referenced eight times. Expert advice on contextual factors was used to alter the forecasts given by the chosen model (judgmental adjustment). They compared the accuracy of a purely quantitative model's predictions to those of the suggested technique and found that the latter's findings were much more accurate. The findings demonstrated the necessity of combining mathematical models with subjectivism, as well as the value of expert viewpoints in predicting

demand more accurately. The objective of this article was to confirm the relevance of integrating contextual aspects, so future advances include a more in-depth investigation of the qualitative portion of the approach. The adoption of formal methods of interviews is suggested to further characterize the problem. Tanizaki et al. (2019) used Bayesian linear regression, boosted decision tree regression, decision forest regression and the stepwise method as the demand (customers visiting) forecasting methods. The results showed that there was no big difference in the forecasting rate using the Bayesian, decision, and stepwise methods, and the forecasting rate of boosted was a little low. They proposed methods for demand forecasting using internal data such as POS data and external data in the ubiquitous environment such as weather, events, etc. This study has been cited 24 times.

In another paper by the same authors, Tanizaki et al. (2020) used the random forest regression (RFR) method (one of machine learning) to forecast the customer order quantity and the inventory order quantity of beer at each store of the restaurant chain R. To improve the accuracy of forecasting, they also used internal and external data. According to the forecasting results of customer order amount, in comparison of a forecasting ratio using learning data for one year and learning data for two years, the results differed depending on the store, and systematic findings were not obtained. They left investigating the effects on the forecasting ratio as well as fitting ratio and preparing for practical use to a future study. This study has not been cited yet. Puspita et al. (2020) used the autoregressive integrated moving (ARIMA) model as a demand forecasting method to control inventory costs. They explained that demand forecasting can be used in a variety of ways ranging from inventory management to shipping, distribution, reclamation, repair, maintenance, the coordination of suppliers, and operating work. This study discussed the material requirement planning (MRP) method with the lot sizing fixed order quantity (FOQ) technique and obtained optimum costs in the supply of some menu items. For future research, they emphasized using more kinds of costs such as labor costs to get a better and more efficient inventory cost. This study has only been cited once. Zháo and Jayadi (2021) proposed forecasting methods for the number of customers and menu item demand using historical POS data and external data. They used the multiple regression model (MRM) and support vector regression machine (SVR) as demand forecasting methods. According to their study, number of visitors forecasts are highly correlated with a work shift, while menu demand forecasts are highly correlated with seasonality and cook type. They mentioned that future research should improve forecasting accuracy and focus on the efficiency of store management. This study has not been cited yet. Otudi and Almaktoom (2021) forecasted demand projection in fast food restaurant by using time series methods. The results showed that the regression method had the lowest error, and double exponential smoothing (DES) recorded the highest level in all aspects from bias to RMSE. The results also proved that a combination of qualitative and quantitative forecasting techniques is usually the most effective approach. They emphasized that the selection of the forecasting model influences the performance and demand patterns faced by retailers. Their study has not been cited yet.

Research in the demand forecasting section focuses on several types of restaurant environments such as institutional food service facilities, casino buffet restaurants, restaurant chains, fast food restaurants, etc. In previous restaurant forecasting studies, demand was measured by meal counts, guest counts, order quantity and inventory order quantity. The most cited article was 47 times. Most of these studies focus on improving the accuracy of forecasting and try to find the most accurate and efficient forecasting methods. Overall, there is a change of direction in forecasting method in the restaurant field from a traditional typology of forecasting techniques such as multiple regression, naïve method, exponential smoothing, and moving average model, to machine learning methods such as Bayesian linear regression, boosted decision tree regression, decision forest regression, the stepwise method and random forest regression. Since a combination of qualitative and quantitative forecasting techniques is generally regarded

as the most effective method, it is emphasized as a future research direction in many studies. In general, most of the studies in this area contribute to improving the accuracy of forecasting methods in a specific restaurant setting, and they suggest that future research should look for a combination of qualitative and quantitative forecasts applicable to a variety of settings.

B. Studies on Forecasting Sales

In an earlier study that has been cited 36 times, Cranage and Andrew (1992) investigated the appropriateness of the econometric model (EM), Box-Jenkins model (BJM), and exponential smoothing model (ESM) for forecasting restaurant sales. They found that time series models (especially exponential smoothing models) are more economical in terms of time and the skill levels of the users and performed better than econometric models in forecasting sales. They also mentioned that due to limited resources, restaurant operators have to evaluate cost-effectiveness to choose forecasting methods with higher accuracy and lower costs. Similarly, the research of Versluis (2016) attempted to determine if it is possible to develop a forecasting tool consisting of one or more models that can predict the daily sales of different restaurants with similar operating environments, which can subsequently be developed into an expert system. The methods used in their study are exponential smoothing model (ESM), ARIMA modeling, and regression analysis (RA). This study's results identified that the best models to be incorporated in the expert system are the multiple-seasonal ARIMA (MS-ARIMA) and multiple-seasonal trigonometric (MS-TBATS) Fourier representations, Box-Cox transformations, ARMA errors, trend, and seasonal components models. According to the results, it can be seen that the accuracy of forecasts depends on various factors, and it is impossible to make the same accurate forecast for all four restaurants. This study has not been cited yet.

Forst (1992) tested three predictors and three forecasting models to find out the best forecasting model for forecasting weekly sales at a small campus restaurant for two years. A multiple regression model with two predictors (a dummy variable and sales lagged one week) was found to be the best forecasting model for weekly sales. This study has been cited 31 times. In a study by Liu et al. (2001), Box-Jenkins seasonal ARIMA models were used to analyze and forecast the time series. A time series data mining method in which automatic time series model identification and automatic outlier detection and adjustment procedures were proposed in this study. The results demonstrated an improvement in forecast performance due to outlier adjustment. Moreover, outlier detection also led to information that can be used not only for better inventory management and planning, but also to identify potential sales opportunities. It's easy to see how a similar method may be used to profit from time series data mining in other business operations. This research has been cited by 120 times.

Takeyasu and Tatebayashi (2016) proposed a new method of estimation of smoothing constant in an exponential smoothing model. Combining the trend removal method with this method, they aimed to increase forecasting accuracy and reported that the proposed method can effectively improve the prediction accuracy. This study has not been cited yet. In another study predicting the sales of campus restaurants that has been cited six times, Xinliang and Dandan (2017) proved that the three-layer BP neural network model is a high precision prediction model that has higher accuracy than the time series model. In another study for predicting restaurant sales, Posch et al. (2021) presented two Bayesian generalized additive models (GAMs) as a new approach for predicting future sales of menu items in restaurants and staff canteens. They proved that the GAMs with a negative binomial distribution often provided the best and most robust point predictions overall. Their research emphasized the importance of features learned by the models, which helped potential users to cultivate the necessary trust and confidence in the methodology. However, the limitation of this study is that their approach only takes into account POS data. In future work, data sources should be enriched by including weather data, information about special events and holidays,

and expert knowledge from restaurant managers. The study was published in 2021 but has been cited two times.

In addition, a study by Lee and Ha (2012) demonstrated the relationships between full-service restaurant sales and significant economic indicators, as well as the consequences of economic recessions on full-service restaurant sales and the full-service restaurant sector's business cycles. This study showed that the gross domestic product was positively correlated with the sales of full-service restaurants and the unemployment rate. Besides that, interest rate and CPI did not have a significant correlation with sales. Moreover, the results also indicated that full-service restaurant sales followed a business cycle pattern roughly every ten years. According to this study, both key economic indicators and the business cycle might be different for other restaurant sectors as compared to full-service restaurants. This study has been cited 34 times. In a recent study by Ganesan et al. (2019), an artificial neural network (ANN) model was proposed to predict food sales in multiplex operators. They reported that the proposed model performed better than the traditional time series models. The authors suggested to improve the efficiency of the current ANN model by factoring in external variables. This study has been cited four times.

In general, most of these studies focus on the appropriateness of multiple models for forecasting restaurant sales and try to develop a forecasting tool consisting of one or more models. These studies generally evaluated forecast models in terms of being more economical and performing better. In addition, many studies on this subject reported the need for restaurant operators to evaluate cost-effectiveness in order to choose a more accurate and lower-cost forecasting method. The most cited article was by Liu et al. (2001), which has been cited 120 times. It is reasonable to say that this article has contributed the most to the body of literature in this subject area. As a common future research proposal, most restaurant sales forecasting studies suggested the need to investigate the application of forecasting models in different types of restaurants.

C. Studies on Forecasting Number of Visitors

Forecasting of visitors provides information that helps restaurants to be much more successful in overcoming the troubles caused by uncertainty factors. Ma et al. (2018) used big data and supervised learning to predict how many future visitors will go to a restaurant. With features constructed from the big data, their approach generates predictions by performing regression using a mix of K-nearest neighbor, random forest and XGBoost. The evaluation results showed the effectiveness of this approach. This study has been cited eight times. As with a study by Padgett et al. (2016) that has been cited three times, the authors of this study also considered that restaurant owners can achieve predictions by using simpler methods. Considering the fact that restaurant owners may not have access to high-performance computers, they showed that predictions can be achieved by a mix of low-computation regressors: K-nearest neighbor, random forest and XGBoost, rather than relying on computation-intensive methods such as deep learning (which requires a long training time and usually a high-performance GPU) and SVM (which requires a huge amount of memory). Moreover, considering many more factors in the forecasting process can facilitate accurate prediction of restaurant future visitors. Hence, in future work, it is necessary to include more information in the predictive model, such as weather, competitors and social events. Future work can also explore new technology-based customer counting approaches for restaurants (such as combining video cameras and the Internet of things, or new software/hardware sensing infrastructure).

A study by Boomija et al. (2018) that has been cited one time used regression techniques to predict visitors. In order to estimate visitors, datasets of reservations and visits to the restaurants were used. The time series data was analyzed by using Box-Jenkins ARIMA models and the residuals have an autoregressive structure. In the experimental results, the proposed system works well in forecasting visitors. This study has been cited once. Love (2021) developed a methodology to forecast monthly customers of eight

McDonald's franchise locations. The research reported that time series analysis performed better than judgmental methods. Companies may also efficiently save costs by accurately forecasting demand using a modified Box-Jenkins methodology. On the other hand, machine learning techniques had been shown to provide much more accurate forecasts of demand than univariate time series techniques. Instead of relying solely on historical demand, they reported that machine learning was able to account for a wide range of variables that could affect future demand such as weather, customer satisfaction scores, events that cause demand spikes, employee staffing, and turnover rates. However, while senior management is typically concerned with the accuracy of forecasting, few understand or have dedicated the resources needed to calculate the cost of forecast error. Therefore, future studies in the field of calculating the cost of forecast error should be pursued. By processing and analyzing large amounts of data, such as financial statements, machine learning techniques can explore the cost of forecast error. This future research could be especially beneficial if a major disruption occurs (such as a pandemic) that could lead to significant and costly forecast errors. This study has not been cited yet.

Overall, the papers related to restaurant visitor forecasting are all in the past 10 years and generally used big data and machine learning methods. In addition, time series models and regression models are also commonly used methods to predict restaurant visitors. They generally emphasized the exploration of how to reduce the cost of forecast error, suggesting that future research should consider more factors on the accuracy of predicting future restaurant visitors. The most cited article in this section was eight times.

D. Studies on Forecasting Company Operating Status

In a study on forecasting company operating status, Youn and Gu (2010) used logistic regression (LR) artificial neural networks (ANNs) methods to predict U.S. restaurant firm failures. The results showed that for restaurant firms, the logistic model not only provided bankruptcy prediction at an accuracy rate as well as no inferior was detected by the ANNs model but also indicated how firms can act to reduce the chance of going bankrupt. However, a major limitation of this study is that their models contain only firm-wise microeconomic information. They proposed incorporation of macroeconomic and non-financial variables in the analysis to predict restaurant firm failure. This research has been cited 62 times. A study by Kim and Upneja (2014), which has been cited 141 times, attempted to determine key financial distress factors for publicly traded U.S. restaurants. This study adapted the decision tree (DT) and AdaBoosted DT models. They recommended the use of the AdaBoosted DT model as an early warning system for restaurant distress because, according to the authors, this model resulted in the best prediction performance. According to their study, financially distressed restaurants relied more heavily on debt and showed lower rates of increase of assets, lower net profit margins, and lower current ratios than non-distressed restaurants. However, the authors of this study performed their analyses on a relatively small sample, necessitating further research using this methodology on a larger population. Since the value of financial ratios largely depends on the economic cycle, it is necessary to study the differences in key financial distress factors during recessions and booms. Moreover, an attempt to improve the algorithm may yield a more interesting model and add more novelty to the research.

Zhang and Luo (2018) studied the leading indicators of restaurant survival and explored whether consumer photos can serve as a leading indicator of long-term business prosperity. They discovered that consumer-posted photos are strong predictors of restaurant survival by using a predictive XGBoost algorithm. Their models can significantly increase restaurant survival forecast accuracy, allowing for better-informed capital investment and lease decisions. However, while they emphasized that there was a positive relationship between consumer-posted photos and restaurant survival, future research should examine how such photos connect to other long-term business outcomes such as customer

attitudes toward the focal business and brand loyalty. This study has been cited seven times so far.

The key literature is for predicting company operating status predictions of restaurant company failures, key financial distress, and restaurant survival. They generally employed a machine learning approach, analyzing variables such as key distress factors, microeconomics, and restaurant financial metrics. These studies underscore the importance of incorporating macroeconomic and non-financial variables into analytical metrics in the future to predict the performance of companies.

E. Studies on Forecasting Restaurant Production and Business Cycle

Other relevant topics include forecasting studies of food production (Miller et al., 1990), future wait time values (Davis et al., 2016) and covers in a commercial food service environment (Miller et al., 1991). Miller et al. (1990) developed forecasting models to improve production forecasting. Simple mathematical models were employed in their study and the results showed that the mathematical models can improve production forecast outcomes. Generic spreadsheet software with simple mathematical models employed requires minimal data storage, and therefore is readily usable in the typical food and beverage operation with minimal equipment and investment. Having the ability to generate accurate wait time estimates would allow restaurant managers to make better business decisions. This research has been cited 37 times. Davis et al. (2016), which has been cited eight times, focused on testing to find the best queue wait time forecasting method. They proposed the development of a wait time estimation algorithm that would be used to generate wait time forecasts using readily available Internet data. The development of this algorithm would be based on dynamic regression, which allows forecasts to be developed with external variables. The results showed that the best queue wait time forecasting method is seasonal-trend decomposition using the LOESS (STL) model. The results mentioned that if a restaurant or restaurant chain provides historical wait time information about its locations, highly accurate wait time forecasts can be made by simply using a time series approach. Miller et al. (1991) purposed simple mathematical forecasting models that can be applied to commercial foodservice operations. They suggested that doing so will enhance the planning process and thus the likelihood of a successful outcome. They reported that the model that performed best was the simple moving average model, indicating that simple mathematical forecasts are practical tools. They left the research to determine if there are any unique impediments to the use of mathematical forecasting models in the hospitality industry. This research has been cited 30 times.

On the other hand, economic indicators and the business cycle are other important fields of restaurant forecasting. As mentioned in section B (Studies on forecasting sales), Lee and Ha (2012) identified the relationships between sales of the full-service restaurant industry and major economic indicators and demonstrated the existence of a business cycle in the full-service restaurant industry. The results of this study revealed that gross domestic product is positively correlated with the sales of full-service restaurants. The results also indicated that the sales at full-service restaurants show a pattern of a business cycle almost every 10 years. In section D (Studies on forecasting company operating status), there is another paper that explored whether consumer photos can serve as a leading indicator of long-term business prosperity. This study found that consumer-posted photos are strong predictors of restaurant survival, as well as photos predicting restaurant survival for up to three years, while reviews are only predictive for one year. Choi, J. G. (2007) developed a business cycle model for the U.S. restaurant industry and analyzed restaurant industry turning points. The findings revealed that the restaurant industry witnessed rapid expansion (boom) every five years on average. Since 1970, the restaurant industry's growth cycles have been reasonably symmetrical with an average duration of 2.25 years for both expansion and contraction. The results of this study helped the restaurant industry and academicians obtain insight into industry cycles, and as a result, eliminate or lessen the risk of making

poor decisions. Even though this study has only been cited 13 times, as key literature about the restaurant industry business cycle, the paper by Choi (2007) was selected for the pool of key literature in the restaurant field.

Overall, related topics in this section include forecasting studies in food production, future wait time values, coverage in the commercial food service environment and developing the restaurant industry business cycle. These studies generally employed simple mathematical models and used less readily available data. They highlight how to make highly accurate predictions in a simple way. The article by Miller et al. (1990) was cited the most, which is 37 times. According to Choi (2007) significant statistical expertise, a good understanding of the necessary statistical data and expert blending of economic theory are needed to ensure success in forecasting. Thus, this study believes that including the research paper from Choi (2007) could help future studies as well as the restaurant industry regarding its economic problems.

IV. Conclusion and Discussion

This study provided a comprehensive review of existing restaurant forecasting research and the contributions and limitations of 29 key studies selected from the period 1990-2021. In order to define the development of forecasting studies in the restaurant industry, prior studies in restaurant forecasting were classified and reviewed according to forecasting area. Forecasting methods have been evolving over the past three decades. Most studies have focused on model building and improving forecasting accuracy, and a few have focused on developing prediction variables. Combined and hybrid models have been used more frequently than single qualitative or quantitative models and techniques. Some of the latest research shows that machine learning techniques can provide more accurate predictions by processing more data. Some researchers also proposed that the cost of error can be explored with the processing and analysis of large amounts of internal (such as financial statements) and external data (such as macroeconomic indicators) through machine learning techniques, so that restaurant operators can take steps proactively to reduce the extra cost of forecast errors. In addition, it should be noted that some advanced time-varying parameter techniques are becoming more popular because of the possibility of changing over time. According to some results, it can be seen that the accuracy of forecasts depends on various factors and external variables (key economic indicators, holidays, temperature, expert knowledge, etc.). However, the limitation of some studies is only taking into account a single factor or data source. In future work, data sources should be enriched by including weather data, information about special events and holidays, and expert knowledge from restaurant managers.

Table 2 shows the top cited article in each subject area. The most cited of sales forecast articles was by Liu et al. (2001), and it has been cited 120 times. The most cited of demand forecast articles was by Hu et al. (2004), and it has been cited 47 times. The most cited of forecasting the number of visitors was by Ma et al. (2018), and it has been cited eight times so far. The most cited of forecasting company operating status was by Kim and Upneja (2014) and has been cited 141 times. And for other subjects, Miller et al. (1990) is the most cited article, which has been cited 37 times. A very important content for the management of restaurants is forecasting for restaurant sales, but now restaurant sales forecasting and management still mainly rely on personal experience without data system support. For small independent restaurants in particular, operators have to evaluate cost-effectiveness to choose forecasting methods with higher accuracy and lower costs due to limited resources. Although sales and demand forecasting are the two areas with the highest number of key papers, research related to the forecasting company operating status is the most cited one. In addition, it can be seen from the continuous increase in the number of visitors forecasting papers in recent years that the number of visitors forecasting research has also received more and more attention from

researchers. This study encourages future researchers to not only try to make more accurate forecasts in existing research areas, but also to expand forecasting areas to reduce the negative impact of uncertainty on restaurant operations.

This study used citation times as a barometer of the contribution of each paper to the body of literature. Table 3 shows the top five articles with the most citations. As can be seen, these articles were published between 2001 and 2014, and the most cited is Kim and Upneja's (2014) article on predicting restaurant financial distress, with a total of 141 citations. This is followed by Liu et al.'s (2001) article on forecasting sales of franchise fast food restaurants, which was cited 120 times. Next is an article on predicting U.S. restaurant firm failures published by Youn and Gu (2010), which was cited 62 times. The fourth one is a paper published by Hu et al. (2004) on the demand for casino buffet restaurants that was cited 47 times. The fifth is a paper by Ryu and Sanchez (2003) on the demand for an institutional foodservice dining facility, which was cited 42 times. Many studies have mentioned that it is impossible to make the same accurate forecast for all types of restaurants. Therefore, they suggested testing the accuracy of forecasting models in different types of restaurants since the accuracy of the models could change for different types of restaurant operations. This also means that researchers can enrich the restaurant prediction literature by comparing the accuracy of forecasting methods for different types of restaurants. However, it also requires restaurant managers not to blindly copy forecasting methods and must measure whether effective forecasting methods from other studies are applicable to the types of restaurants they operate.

On the other hand, it is necessary to analyze the average citation times per year. This is because of the fact that each article was published in different

Table 2. Top cited articles by subject area

Subject area	Author	Year	Citation times	Title
Sales	Liu, Bhattacharyya, Sclove, Chen, & Lattyak	2001	120	Data mining on time series: an illustration using fast-food restaurant franchise data
Demand	Hu, Chen, & McCain	2004	47	Forecasting in short-term planning and management for a casino buffet restaurant
Number of visitors	Ma, Tian, Luo, & Zhang	2018	8	Predicting future visitors of restaurants using big data
Company operating status	Kim & Upneja	2014	141	Predicting restaurant financial distress using decision tree and AdaBoosted decision tree models
Others	Miller, McCahon, & Bloss	1990	37	Food production forecasting with simple time series models

Table 3. Top 5 key literature sorted by citation times

No.	Author	Year	Title	Citation Times
1	Kim & Upneja	2014	Predicting restaurant financial distress using decision tree and AdaBoosted decision tree models	141
2	Liu, Bhattacharyya, Sclove, Chen, & Lattyak	2001	Data mining on time series: an illustration using fast-food restaurant franchise data	120
3	Youn & Gu	2010	Predict US restaurant firm failures: The artificial neural network model versus logistic regression model	62
4	Hu, Chen, & McCain	2004	Forecasting in short-term planning and management for a casino buffet restaurant	47
5	Ryu & Sanchez	2003	The evaluation of forecasting methods at an institutional foodservice dining facility	42

year, which means different periods. Thus, revealing the average citation times articulates the real contribution of each paper and shows the importance of the annual influence of the article. The top five key works of literature ranked by the average citation per year are shown in Table 4. Among them, the article by Kim and Upneja (2014) ranks first in both ranking methods, suggesting that this study is the most impactful as individual research. This is followed by a paper on demand forecasting published by Tanizaki et al. (2019). The third and fourth papers are from Liu et al. (2001) and Youn & Gu (2010), respectively, which are also among the top five most cited papers. The last one is Lee and Ha (2012)'s article on predicting restaurant sales. It is worth noting that the articles by Kim and Upneja (2014), Liu et al. (2001), and Youn and Gu (2010) appeared in both the top 5 articles with the most total citations and the top 5 articles with the most average annual citations. These articles all used machine learning methods, including the decision tree, the AdaBoosted decision tree, artificial neural network models and logistic regression models, etc. This illustrates the importance of machine learning methods in future research. At the same time, this also confirms the results of some studies that "machine learning technology can provide more accurate predictions by processing more data." Therefore, this study suggests that researchers use machine learning methods to analyze large amounts of data to obtain accurate prediction results. In addition, comparisons between various machine learning methods and the types of restaurants are applicable and worth exploring in future studies.

In addition, by reviewing the affiliations of the first authors of these studies, this paper finds that the country with the most key articles is the United States with 13 articles, Japan and Indonesia come in second with three articles each, followed by China and India with two articles each. South Korea, South Africa, Brazil, Austria, and Saudi Arabia each have one paper. Table 5 summarizes information on the countries of the first authors of these studies. It can be seen that the United States is the country that publishes the earliest and most papers related to restaurant forecasting, which reflects the status of American academic research. In addition, many related papers have also been published in Asian countries in the past decade, which shows that Asian countries are paying more and more attention to restaurant forecasting. The study of the accuracy of the restaurant forecasting methods in different countries is also worth to be done in the future research due to the different macroeconomic environments and business policies of various countries.

Forecasting methods have been evolving over the past three decades. Most studies have focused on model building and improving forecasting accuracy, while a few have focused on developing prediction variables. Combined and hybrid models have been used more frequently than single qualitative or quantitative models and techniques. Some of the latest research shows that machine learning techniques can provide more accurate predictions by processing more data. Many researchers also proposed that the cost of error can be explored with the processing and analysis of large amounts of internal (such as financial statements) and external data (such as macroeconomic indicators) through machine learning techniques so that the restaurant operators can take steps proactively to reduce the extra cost of forecast errors. In addition, it should be noted that some advanced time-varying parameter techniques are becoming more popular because of the possibility of changing over time. According to some results, it can be seen that the accuracy of forecasts depends on various factors and external variables (key economic indicators, holidays, temperature, expert knowledge, etc). However, the limitation of some studies is only taking into account a single factor or data source. Hence, in future work, data sources should be enriched by including weather data, information about special events and holidays, and expert knowledge from the restaurant managers.

Although forecasting is one of the most important research topics in the hospitality industry, it is also important to note that few literature reviews are concerned with the contributions and limitations of forecasting research within the restaurant sector. In fact, most studies that discuss forecasting have done

so as a way to inform the reader regarding forecasting model construction, and performance evaluation. They generally have focused only on finding publication trends and comparing research methods by quantitative bibliometric techniques in the scholarly tourism journals. As such, given the absence of a systemic review of the forecasting research in the restaurant sector, this study not only provided a snapshot of the current citation status of key studies conducted between 1990 and 2021, but also identified the overall development, contributions, and limitations of the restaurant forecasting research. Therefore, the findings of this study could enrich research on restaurant forecasting, thereby providing more perspectives for scholars and restaurant operators. This study contributed to the existing body of knowledge by providing novel insight in terms of the development of forecasting approaches and further trends. Through a comprehensive overview of the overall development, contributions and limitations of forecasting studies in the restaurant field, researchers can see the subjects and types of research that have already been conducted and which topics remain unexamined. Additionally, although this review and analysis focused on what the future

Table 4. Top 5 key literatures sorted by average cited per year

No.	Author	Year	Title	Citation Times	Average citations per year
1	Kim & Upneja	2014	Predicting restaurant financial distress using decision tree and AdaBoosted decision tree models	141	20.14
2	Tanizaki, Hoshino, Shimmura, & Takenaka	2019	Demand forecasting in restaurants using machine learning and statistical analysis	24	12.00
3	Liu, Bhattacharyya, Sclove, Chen, & Lattyak	2001	Data mining on time series: an illustration using fast-food restaurant franchise data	120	6.00
4	Youn & Gu	2010	Predict US restaurant firm failures: The artificial neural network model versus logistic regression model	62	5.64
5	Lee & Ha	2012	Exploring the impacts of key economic indicators and economic recessions in the restaurant industry	34	3.78

Table 5. Numbers of key literature by first author's nation

Nation	Number of articles	Author and year
USA	13	Miller, McCahon, & Bloss, 1990; Miller, McCahon, & Miller, 1991; Cranage & Andrew, 1992; Forst, 1992; Liu, Bhattacharyya, Sclove, Chen, & Lattyak, 2001; Ryu & Sanchez, 2003; Hu, Chen, & McCain, 2004; Youn & Gu, 2010; Lee & Ha, 2012; Davis, Rogers, & Huang, 2016; Padgett, DeVincenzo, Munn, & Rajagopalan, 2016; Zhang & Luo, 2018; Love, 2021
Japan	3	Takeyasu & Tatebayashi, 2016; Tanizaki, Hoshino, Shimmura, & Takenaka, 2019; Tanizaki, Hoshino, Shimmura, & Takenaka, 2020
Indonesia	3	Hidayatullah & Yudoko, 2016; Puspita, Primadani, & Susanti, 2020; Zháo & Jayadi, 2021
China	2	Xinliang & Dandan, 2017; Ma, Tian, Luo, & Zhang, 2018
India	2	Boomija, Anandaraj, Nandhini, & Lavanya, 2018; Ganesan, Divi, Moudhgalya, Sriharsha, & Vijayaraghavan, 2019
South Korea	2	Kim & Upneja, 2014; Choi, 2007
South Africa	1	Versluis, 2016
Brazil	1	Meneghini, Anzanello, Kahmann, & Tortorella, 2018
Austria	1	Posch, Truden, Hungerländer, & Pilz, 2021
Saudi Arabia	1	Otudi & Almaktoom, 2021

researchers should focus on, this study also provided restaurant operators with a rough forecasting methodology guide to better forecast and analyze restaurant sales, demand, visitor numbers, company operations conditions, etc. Restaurant managers must be aware of changing demand levels and economic fluctuations in advance to effectively control costs and increase productivity. By reviewing these restaurant forecasting studies, we recommend that managers should analyze as much internal (e.g., financial statements) and external data (e.g., macroeconomic indicators) as possible using the simplest forecasting method to achieve the most accurate results at the lowest possible cost of forecast errors.

V. Limitations and Further Research

Like all research, this study is subject to imperfections. In order to determine a pool of key forecasting literature in the restaurant field, this study used the citation count to measure the impact of a study. While this serves the purpose of this study, citation counts may not perfectly represent the value and impact of a study. Future research could consider using multiple data and count methods to measure the impact of a study.

Compared with the tourism and hotel industry, the forecasting literature for the restaurant industry is relatively rare and lacks summative papers. While this study attempts to provide a comprehensive perspective on forecasting research in the restaurant industry, there are no other papers' findings that can be used for comparison. Future research is necessary to find similarities and differences in the forecasting literature of the restaurant, hotel, and tourism industries, and find the possibilities and limitations of cross-disciplinary references.

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