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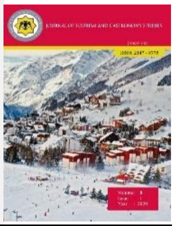

The Application of the Plate Waste on Menu Analysis**

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Abstract

In the study, it is aimed to determine the amount of plate waste and to use it with menu engineering (ME) method which is one of the most prevalent menu analysis approach in terms of literature and practices. A case study was conducted in a fine-dining restaurant in Antalya. In the study, 10 food items which are in the main course category on the dinner menu were taken into consideration. Material cost, sales amount and price data were collected through the document review while plate waste data was collected by using a digital camera. At the end of the research, it has been revealed that the amount of plate waste can be used effectively in the menu analysis. Thus, the customer's point of view was included in the menu evaluation process which mostly reflects the business perspective. Therefore, more detailed performance data has been provided regarding menu items. In terms of restaurant managers, this means that the results of analysis can serve for both short-and long-term business purposes.

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INTRODUCTION

The menu represents the product range of companies as the main marketing tool in food and beverage operations, sets prices and sets out promotional opportunities (Atkinson & Jones, 1993). However, the menu also guides many business decisions from the procurement of materials to preparation and subsequent service. Moreover, it is seen as the center of food production and has a direct impact on demand, supply and profitability (Kivela, 2003; Annaraud, 2007; Taylor et al., 2009). Therefore, it has become a necessity for menus to be evaluated effectively in food and beverage companies in particular which operate in an environment where competition is fierce and market conditions are flexible.

Menu analysis is one of the most basic tools used in the menu evaluation process (Antun & Gustafson, 2005; Annaraud, 2007). With this analysis, it is possible to plan the menus in a proper way, establish an efficient pricing and cost control system, carry out in-service training, determine the target customer group and develop appropriate strategies for them (Kwong, 2005; Taylor & Brown, 2007). In its most general terms, menu analysis is the systematic identification and evaluation of the performances of menu items. Several menu analysis approaches have been developed since the 1980s (Miller, 1980; Kasavana & Smith, 1982; Pavesic, 1985; Hayes & Huffman, 1985; Bayou & Bennett, 1992; LeBruto et al., 1995; Raab & Mayer, 2007; Taylor et al., 2009). The main objective of every approach developed has been to increase the profitability of the menu. However, the most prominent approach in terms of theory and practice has been the matrix-based approach called Menu Engineering (ME) (Pavesic, 1983; LeBruto et al., 1995; Mifli, 2000; Kwong, 2005; Raab & Mayer, 2007; Taylor et al., 2009).

ME is an approach that compares the performance of menu items with their popularity (sales amount) and contribution margin. The most important advantage is that its simplicity as well as being economical and easy to understand. Three data which are price, material cost and sales numbers and standard mathematical knowledge is sufficient for implementation. However, this advantage also represents the weakness of the approach. Therefore, various authors have attempted to develop the approach taking into account the number and characteristics of the variables used in the analysis (LeBruto et al., 1995; Horton, 2001; Raab & Mayer, 2007, Taylor et al., 2009). However, criticism for classic ME as well as the criticism made in subsequent years has focused more on the data that reflected the business perspective while the costumer point of view was often ignored. At first glance the popularity used in the ME process can be seen as data on customer satisfaction. However, in order to consider popularity as an indicator of satisfaction in restaurant, it is necessary to look at the characteristics of the customers. It is possible to establish an association between the high number of repeat visitors and satisfaction, that is, selling to the same people to a large extent. On the other hand, if the numbers of new customers are high depending on factors such as company location, competition, demand, and marketing efforts, it would be misleading to associate popularity with customer satisfaction. Therefore, for more effective and more comprehensive menu evaluations, data that can be associated with customer satisfaction better should be included in the analysis process.

In Expectation-Disconfirmation Theory (EDT), satisfaction is a response to consumed or used product/service (Oliver, 1980). According to EDT, at least two variables are needed to emerge the consumer satisfaction. These are the outcome of using the product (experience or perceived performance) and a reference point (expectation, desire or standards). Consumer's perception of overall satisfaction results from a comparison between expectation and outcome performance. If the experience meets or exceeds the expectation, the expectation is positively disconfirmed and the consumer is satisfied. On the contrary, the expectation is negatively disconfirmed and thus the dissatisfaction occurs. Given some theoretical and operational problems associated with easement expectations, many researchers consider that perceived performance (i.e., output) alone is the best predictor for measuring consumer satisfaction (Yüksel & Rimmington, 1998: Wirtz & Mattila, 2001; Petrick, 2004). So it is possible to measure customer satisfaction with only consumption data. The most important question that arises at this point is to determine which consumption level will be taken as a reference point in the determination of consumer satisfaction.

In many menu analysis methods, food performances are mostly expressed on average values (Taylor & Brown, 2007; Ozdemir, 2012). For example, in menu engineering, foods with a higher contribution margin than the average contribution are considered more profitable. In this context, it is possible to accept the average amount of food consumption (or plate waste) as a reference point. The food waste that was left on plates reveals both the customers' food consumption and how much the food or menus are really approved. Some authors suggest that plate waste can be used as a significant variable in measuring menu efficiency (Connors & Rozell, 2004; Massow & McAdams, 2015). Reducing the amount of plate waste can contribute to the development of customer satisfaction as well as the quality of food service. In this context, low food waste amount is associated with high customer satisfaction (Ferreira et al., 2013; Massow & McAdams, 2015; Haugaard & Lahteenmaki, 2017).

Literature Review

Menu Analysis and Menu Engineering

The concepts of menu analysis and menu engineering are sometimes encountered as concepts that are used interchangeably in the literature. However, both concepts do not mean the same thing. Menu analysis also includes menu engineering as a broader concept. In other words, menu engineering is just one of the different menu analysis methods or approaches (Mifli, 2000). Atkinson and Jones (1993) describe menu analysis as a mathematical technique that evaluates the performance of each menu structure and distinguishes between low and high-performance menu items, revealing performance differences. An analysis of the field literature indicates that menu analysis is a very popular research topic (Jones & Mifli, 2001; Ozdemir & Caliskan, 2014). Within this context, menu analysis approaches with different characteristics have been developed especially since the 1980s. The most prominent studies are shown in chronological order in Table 1. As evident in Table 1, the first menu analysis approach in an analytical sense was developed by Miller (1980) on a matrix basis. Miller has paved the way for scientific menu analysis studies by adapting the quaternary matrix approach known as the Boston Working Group Portfolio Analysis to assess the performance of menu items. Each new analytical method developed in the following years has usually been generated based on the deficiencies of the previous method. However, it is not right to assess which method is best or which is the worst. Nevertheless, it is possible to say that among the existing menu analysis studies, the approach developed by Kasavana and Smith (1982) is the most popular one in terms of theory and practice (Pavesic, 1983; LeBruto et al., 1995; Morrison, 1996; Mifli, 2000; Kwong, 2005; Lee & Lee 2006; Raab & Mayer, 2007; Linassi et al., 2016).

Table 1. Main Menu Analysis Approaches

Year	Author(s)	Menu Analysis Approach
1980	Miller, J.	First Matrix Approach
1982	Kasavana, M. & Smith, D.	Menu Engineering Matrix
1983	Pavesic, D. V.	Cost-Contribution Margin Matrix
1985	Pavesic, D. V.	Profit Factor Analysis
1985	Hayes, D. K. &Huffman, L.	Goal Value Analysis
1992	Bayou, M. E. &Bennett, L.B.	Hierarchical Profitability Analysis
1993	Atkinson, H. &Jones, P.	Micro-Marketing Mix
1995	Beran, B.	Marginal and Cumulative Analysis
1995	LeBruto et al.	Three-Dimensional Matrix
1998	Cohen et al.	Multi-Dimensional Approach
2007	Annaraud, K.	Index Method
2007	Raab, C. &Mayer, K.	Activity Based Costing ME
2009	Taylor et al.	Multi Factor Menu Analysis
2011	Yang, C.Y. &Chiang, T.Y.	Real Option Pricing Model

Reference: Adapted from Raab et al. (2007) and Ozdemir (2012)

Kasavana and Smith (1982) argued that the profitability expressed in the Miller (1980) model cannot be characterized only as a percentage of the cost of food and indicated that this should be replaced with the contribution margin. In this approach, which is described as Menu Engineering in the literature (Morrison, 1996; Kwong, 2005; Raab & Mayer, 2007), the contribution margin is determined as the difference between the selling price of a menu item and the variable cost. The relevant authors have also used the popularity index instead of menu sales quantities as the other matrix dimension.

The general approach followed in determining the total sales contribution of each food item on the menu is manifested with calculations done by selecting an appropriate contribution parameter. The excellence ratings of menus are generally estimated at 70% - this ratio is claimed to have emerged as a result of research by experts in menu engineering (Ninemeier, 1995) and this rate is taken into account when calculating the optimal menu mix. The 70% factor is based on the belief that it is not reasonable to require each menu item to maintain the mathematical sales percentage of 1/n in order to be ranked as high in popularity. The use of this 70% popularity factor has become accepted practice among knowledgeable restaurateurs (Atkinson & Jones, 1993; LeBruto, et al, 1995; Raab, et al., 2007).

The most important advantage ME method has in terms of implementation is its simplicity, being economical and easy to understand. There are commercial package programs developed for ME application such as MenuMax, Resort Software, Lucidpos and Ezchef on the market. However, standard mathematical information and a spreadsheet program such as Microsoft Excel are enough for the analysis to be done without undertaking any financial burden. On the other hand, thanks to the quaternary matrix created in the context of ME, the relevant managers can easily understand the analysis results (Atkinson & Lones, 1993; Ozdemir, 2012). The criticism regarding the ME approach focuses on the number and characteristics of the variables used in the analysis. In this context, the issue which has received the most criticism in ME has been the form of the contribution margin and calculation (Morrison, 1996; Raab & Mayer, 2007). In the ME approach, a limited number of financial data such as cost, price, contribution margin and sales amount are used and data related to customer satisfaction or related variables are not taken into consideration.

Plate Waste

Food waste is defined as “any food that is not consumed by humans and can be generated at any level within the food chain” (Okazaki et al. 2008). Food waste is one of the most important global issues causing economic, environmental and social impacts. Approximately one third of global food production is wasted every year (Gustavsson et al., 2011; Betz et al., 2015; Principato et al., 2018).

The exact amount of food waste in the hospitality industry is unknown, but it is estimated that hotels, restaurants, and the catering sector generate about 14% (BIO Intelligence Services 2010) of the total food waste in the European Union (Juvan et al., 2018). For example, in France 15% (Sirieix et al., 2017), in the Netherlands 14% (Duursma et al., 2015) and in UK 22% (SRA, 2010) of the total food waste are attributed to the hospitality and food services. The studies mentioned that food waste is the most significant component of hospitality waste, being approximately 40% of the waste from hotels and 60% of the waste from restaurants (Pirani & Arafat, 2014). These values clearly show the significant food waste is as a component of the waste stream of the hospitality industry.

Food waste incurs during all service processes such as delivery, storage, preparation, cooking, service and final customer consumption. According to WRAP (2009), on average 21% of food waste arises from spoilage, %45 from food preparation and %34 from consumer plates in UK hospitality and food service sector. Especially in developed country restaurants, the significant amount of food waste consists of plate waste (Engström & Carlsson-Kanyama, 2004; Silvennoinen et al., 2012; Betz et al., 2015). For example, In UK restaurants, 30% of food waste comes back from customers' plates (SRA, 2010). Plate waste is unconsumed food left on the customers' plates. These leftovers are generally assessed in two groups as avoidable and unavoidable (Gustavsson et al., 2011; Parfitt et al., 2013; Papargyropoulou et al., 2016). Related research showed that most of these waste is consist of avoidable (Engström & Carlsson-Kanyama, 2004; Silvennoinen et al., 2012). That’s why the restaurants such as every food service companies have sign fact opportunity to decrease the plate waste. As a matter of fact, avoidable plate waste (customers’ leftovers) is taken into consideration in some studies (Pirani & Arafat, 2014; Massow& McAdams, 2015). Plate waste is an important consideration in restaurant businesses in terms of both short-term and long-term goals. By reviewing and evaluating plate waste it is possible to develop or arrange more guest-oriented menus so that the competitiveness of the enterprises can be supported (Connors & Rozell, 2004; Massow & McAdams, 2015). The control of waste or consumption index allows evaluating the adequacy of prepared quantities in relation to consumption needs, food individual quantities as well as menus acceptance. The higher waste (lower consumption) index indicates a higher consumer’s satisfaction. Avoiding waste also means increasing profitability of a food unit, since increased waste accomplish for an important part of costs, related to raw material, labor force and equipment (Ferreira et al., 2013). However, a review of literature indicates that most of the studies have been conducted in institutions such as hospitals and schools (Graves & Shannon, 1983; Jacko et al., 2007; Kandiah et al., 2006; Williams & Walton, 2011; Ferreira et al., 2013). Most of this research has looked at plate waste in the context of nutritional requirements in an institutional setting. On the other hand, the number of studies with examples from tourism enterprises such as cafeterias and hotels, especially restaurant establishments, is very limited (Massow & McAdams, 2015; Kuo & Shih, 2016). This study is one of the first to look at the issue in a fine-dining restaurant setting. Three different methods are mainly used in plate waste application studies. These are the weighing method, visual methods and survey application. Each method has its own advantages and disadvantages. For example, weighing is a method that requires more labor, space, time and equipment. Therefore, it is considered to be a difficult and costly method to implement (Connors & Rozell, 2004, Williams & Walton, 2011; Martins et al., 2014). The survey method is relatively easy to implement and at a relatively low cost. However, the adequacy and reliability of the obtained data is low. With visual methods, the amount of waste left on the plate is determined and measured by observation or photography. The weakness of this method is that the measurements and evaluations are made more subjectively. However, similar results can be obtained by weighing and visual measurements made under suitable conditions, especially using digital cameras (Williams & Walton, 2011). Nevertheless, the most important advantage of visual methods is that they can provide meaningful data without interfering with food service activities (Martins et al., 2014).

Expectancy Disconfirmation Theory (EDT)

Customer satisfaction is one of the most important topics for restaurant managers, because satisfied customers can generate long-term benefits for company, including customer loyalty and sustained profitability (Kivela et al., 1999; Namkung & Jang, 2007). There are a number of theories in the hospitality literature that have been developed to explain customer satisfaction (Yüksel & Yüksel, 2001; Liu & Jang, 2009; Pizam et al., 2016). Expectation-Harmonization theory is one of the most widely used of these theories (Oliver, 1980; Huh & Uysal, 2003; Weiss et al., 2005; Ryu & Zhong, 2012; Haugaard, & Lahteenmaki, 2017). This theory has been used in several studies to evaluate the role of consumers' expectations in food acceptance (Cardello, 1995; Johns, & Pine, 2002; Hauteville et al., 2007). The theory which was developed by Oliver (1980) has two main variables, expectation (E) and perceived performance (P). The difference between these variables is determined as disconfirmation (P-E). The disconfirmation can be either positive or negative. When a customer's experience (perceived performance) with a specific product equals or exceeds his/her expectation, positive disconfirmation that will lead to customer satisfaction occurs ($P \geq E$). Otherwise, negative disconfirmation which means products or services are not enough to provide customer satisfaction emerges ($P < E$).

Expectations have generally been predictive values, but other standards such as desires, needs, and norms have also been used in practice (Oliver, 1980; Tse & Wilton, 1988; Spreng & Page, 2003). Miller (1977) categorized four types of expectation comparison standards as the minimum tolerable level (must be), the deserved level (should be), the expected level (will be) and the ideal level (can be). The ideal level of product performance represents the optimal product performance that a customer should want to obtain (it should happen) (Bowen & Clarke, 2002). Tse (1994) suggested that quality of service could be measured by using ideal standard data as the expectation data. In this study, ideal standard was used as the expectation data. When food consumption is considered, customers can quite likely expect a minimum or even zero plate waste as an ideal standard. So, the restaurant customers generally want to consume the entire menu that they ordered. This means that menu items with zero amount of plate waste provide ideal expectation levels and thus lead to customer satisfaction. There is no known ideal or acceptable plate waste level. Although there is no acceptable level of plate waste, it is considered that values below 10% of plate waste is acceptable (Williams & Walton, 2011; Carvalho et al. 2015: Marais, et al. 2017). According to Vaz (2006), plate waste values up to 3% are acceptable in restaurants.

In ME, performance evaluations of menu items are performed on average data. For example, when evaluating profitability, the average contribution margin (dividing the menu's total contribution margin by the total number of menu items sold) is calculated by taking into account all menu items and the contribution of each menu item is compared with the average contribution margin. In the same way, the average popularity values are calculated and the popularity of each menu is determined according to the calculated average values (Kasavana & Smith, 1982; Taylor & Brown, 2007). So, the performance of the menu items is shown by comparing all the menu items in ME. In this context, the average data was taken into consideration when integrating the customer perspective into the menu engineering process. Therefore, in this study, the average amount of menus plate waste was used as the ideal standard.

Methodology

A case study was conducted in a fine-dining restaurant in the study. A case study is one of the most suitable research strategies for comprehensive menu analysis studies. As a matter of fact, most of the menu analysis studies carried out in the previous years was done in a similar way with samples from a single food and beverage company (Kasavana & Smith, 1980; Mifli, 2000; Raab & Mayer, 2007; Taylor et al., 2009). As a sampling method, purposeful sampling method which is used in both qualitative and quantitative studies have been preferred. In this context, it has been decided to determine a fine-dining restaurant as a data collection area based on volunteerism. Many authors define food and beverages as restaurants' core products (Kivela et al., 1999; Reynolds & Beil, 2007; Ozdemir & Caliskan, 2014). Since food is one of the most influential restaurant selection attributes and a determinant of customer satisfaction and retention (Kivela et al., 1999), food and beverages constitute the core of meal experience (Gustafsson, 2004). Considering the qualities of fine-dining restaurants (food portion sizes, average mealtime, comfort, music, atmosphere etc.), it is possible to assess the amount of plate waste as a significant satisfaction indicator. The place where the study was carried out is a fine-dining restaurant established in 2009 in Antalya-Turkey. There were approximately 22 tables in the in- and outdoor venues of the restaurant with a seating capacity for 80 people. Most of the restaurant's guest portfolio was comprised of foreign tourists. According to the statement of the restaurant manager, about 60% of the guests who come to the restaurant are foreigners. The restaurant has 3 different menus, one for dinner, one for lunch and a wine menu. Each menu has a different food and beverage group, such as starters, main course and desserts. The business manager informed that a significant portion of the restaurant's income came from dinners. Of course, the influence of the wine menu was significant in the manifestation of this difference. However, it is expected that dinner sales in fine-dining restaurant businesses are higher than lunch sales. Therefore, the main focus of the business was on the evening menu and concentrated only on 10 main dishes. These are Char-Grilled Chicken (F1), Lamb Cotlet (F2), Bonfser (F3), Beef Wellington (F4), Char Grilled Rib Steak (F5), Roasted Stuffed Steak (F6), Confit of Duck (F7), Mediterranean Breeze (F8), Sea Bass Wrapped in Wine Leaves (F9) and Fish from the Hook (F10).

The ME method developed by Kasavana & Smith (1982) was used for the evaluation of the dinner menus in the study. This method is one of the most widely used menu analysis methods in practice and academia. In fact this method has been referenced the most for menu analysis studies carried out in recent years (Kwong, 2005; Lee & Lee, 2006; Raab& Mayer, 2007; Taylor et al., 2009). Menu engineering can easily be achieved with simple spreadsheet programs. Therefore, Microsoft Excel program was used in the ME analysis process. Three different basic data are needed in order to implement the Menu Engineering Method. These are the sales amount, sales price and unit cost of each menu item. Material cost data can easily be obtained from inventory records and standard recipes. The restaurant has an automation system used for this purpose. Therefore, unit material costs have been obtained through the program used. On the other hand, the sales quantities of the menu items have been provided from end of the day cash reports and the sales price data have been provided from the menu cards.

The plate waste in the study has been determined by visual method. There are different measuring scales developed for this purpose in practice. The most common of these is the 7-point scale developed by Sherwin et al. (1998) and the 6-point scale developed by Comstock et al. (1981). Apart from these, there are also different measuring scales distinguished in the form of 5, 4 and even 3 points (Graves & Shannon, 1983; Kandiah et al., 2006). In the interviews done at the back of the restaurant, the dishwasher noted that the plate waste was usually minimal. Similarly, some studies carried out with restaurant samples indicated that the plate waste amounts were between 4% and 8% (Katajajuuri et al., 2011; Papargyropoulou et al., 2016). Therefore, the 7-point scale developed by Sherwin et al. (1998), which has more distinguishing features, has been used in the study. The relevant scale and explanations of the scales are shown in the Table 2.

Table 2. Seven Point Likert Scale for Visual Plate Waste

Score	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Description	None left	Mouthful left	1/4 left	1/2 left	3/4 left	Mouthful eaten	All left
Waste Percent	0	10	25	50	75	90	100

Reference: Sherwin et al. (1998).

At the back of the restaurant operation, simultaneous measurements were made with a digital camera and an electronic scale with 1-gram precision to determine the amount of plate waste. Initially, each menu item which is ready to be served was recorded ad hoc. These records were used as a basis to measure the waste amount of menu items. Subsequently, the plate waste on every plate returned to the venue was determined. The plate waste recordings were made with a digital camera on a small table placed next to the dishwasher so that the workflow was not interrupted. Plates with no waste, in other words plates for which the menu items had been completely consumed were not photographed. The food that had been on these plates was determined by asking the service and kitchen staff.

Results

The data collected during the activity period covering September 2013 and the results of the classic ME generated in the Excel program using these data are shown in the following Table 3. As seen in the table, there are two basic values that are taken into consideration when determining the location of the menu items on the quaternary matrix. One of these values is the level of appreciation for each food and the other is the mean of the contribution margin.

Food items with a sales amount of 7% or more are determined to have a high popularity and those below this value are considered to have a low popularity as indicated in the Table 3. Under these circumstances, only two menu items are below the level of appreciation. Considering the whole business, a large part of the main dishes being appreciated is thought to have a positive result. When evaluating according to the mean of the contribution margin, the contribution margin of half of the food was found to be inadequate. This alone can be regarded as a rather negative indicator for the business. However, when the popularity and contribution margin are evaluated together, the performance of 4 menu items, namely F3, F4, F5 and F9 were determined as very good (the star). On the other hand, the only poor food performance (the dog) was F6. The remaining 5 food items were considered improvable (the plowhorse and the puzzle). Under the circumstances half of the main courses need to be reviewed. Thus, it is possible to improve the success of the restaurant by more than 50%. In the related literature, there are usually very few suggestions for the star and the dog at the end of the ME matrix. More options have been presented to the other two groups (Kwong, 2005; Taylor & Brown, 2007). For the relevant business, this means that there is a substantial opportunity to improve the profitability of the main course. Therefore, all employees, especially the business manager and the chef, should make more effort, especially in terms of improvable food items.

Table 3. Menu Engineering Results

Dinner Main Courses							**1September - 30 September**		
Menu Item	Price (1)	Cost (2)	Contribution Margin (1-2) (3)	Sales Amount (4)	Popularity (%)	Total Contribution Margin(3*4)	Popularity Status *	Profit Status **	Menu Matrix Group
F1	29	6,15	22,9	122	7,8%	2788	High	Low	Plow
F2	45	26,08	18,9	164	10,5%	3103	High	Low	Plow
F3	43	11,68	31,3	292	18,7%	9145	High	High	Star
F4	44	10,16	33,8	178	11,4%	6024	High	High	Star
F5	43	12,75	30,3	164	10,5%	4961	High	High	Star
F6	35	11,05	24,0	78	5,0%	1868	Low	Low	Dog
F7	41	21,55	19,5	114	7,3%	2217	High	Low	Plow
F8	50	24,27	25,7	205	13,1%	5275	High	Low	Plow
F9	37	5,60	31,4	168	10,8%	5275	High	High	Star
F10	32	4,38	27,6	75	4,8%	2072	Low	High	Puzzle
Total		134	265,0	1560	100%	42727			
Popularity Index = (1/10) x 0,70= 0,07 = % 7; Contribution Margin = 42727 / 1560 = 27,4									
The Currency is the Turkish lira. 1$ = 2.0365 TL (Announced on 09/30/2013 by the Central Bank of Turkey).									
*If the Popularity is less than the Popularity Index**, Low**, If it is equal or higher, **High.**									
If the Contribution Margin is less than mean of Contribution Margin, **Low, if it is equal or higher, **High.**									

While the plate waste was being analyzed, the standard image of each of the menus was recorded first. Records of the plates returned from guest consumption were then compared with these standard records and evaluated on a 7-point Likert scale. For example, the F1 menu and the five plate wastes are shown in Figure 1. Since no leftover remained on the plate in the second picture, it has been rated as 1. In the third and fourth pictures, very little (about 10-15%) leftover is evident. Therefore, the plate has been rated with a 2. In the fifth picture there is relatively more leftover (approx. 20-25%) and the plate has been rated with 3 and in the sixth and last picture the leftover amounts to almost half of the plate (40-50%) and has been rated with 4.

Figure 1. Visual Records of F1 Menu Item

Total of 18 observations were made for the F1 menu item. Of these observations, no leftovers were present in 13 of them. On the other hand, only 2 observations were detected with 10-15% and 20-30% on average, while only 1 observation (sixth image) displayed almost half a plate of leftovers. The other main meal items were identified as was done in the case of F1 and recorded in the SPSS package program and the data for the final plate waste given in Table 4 has been generated.

Table 4. Plate Waste Amount of the Main Course Items

Menu ıtem	n	Minimum	Maximum	Plate Waste	Standard Deviation	Waste Status (*)
F1	18	1,00	4,00	1,50	,92355	High
F2	13	1,00	2,00	1,15	,37553	Low
F3	21	1,00	3,00	1,38	,74001	Low
F4	11	1,00	2,00	1,36	,50452	Low
F5	18	1,00	3,00	1,22	,64676	Low
F6	16	1,00	3,00	1,56	,72744	High
F7	17	1,00	3,00	1,24	,56230	Low
F8	16	1,00	3,00	1,38	,61914	Low
F9	17	1,00	3,00	1,82	,80896	High
F10	07	1,00	3,00	1,57	,97590	High
mean				**1,42**		

*If the plate waste is lower than the mean ($\bar{X}$= 1, 42) its waste status is **Low**, If it is not, is **High**.

A total of 154 observations have been made for 10 main food items, as seen in the table above. In observations, the minimum plate waste was determined to be 0% (1) while the maximum amount was 50% (4). When the overall mean of the main dishes ($\bar{X}$= 1, 42) is taken into consideration the amount of plate waste is observed to be about 4.2% (1 is equal to 0%, 2 is equal to 10% plate waste). The fact that the portions offered by fine-dining restaurant establishments are relatively small, the average mealtime is longer and the eating environment is pleasant, low plate waste is considered to be an anticipated result. This result coincides with the results of previous studies by Katajajuuri et al. (2011). They concluded that the plate waste was about 4-8% in Finnish restaurants. When only plate waste value is evaluated, these amounts can be seen as acceptable. Because some researchers have stated that plate waste values below 10% are acceptable (Carvalho et al., 2015: Marais et al., 2017). However, these values have emerged in institutional food service establishments such as schools and hospitals or in ordinary food enterprises. Therefore, the acceptable plate waste level may vary according to the operation from the operation, depending on various factors. The portions offered by fine-dining is relatively small, the average meal time is longer and the eating environment is pleasant. Therefore, lower plate waste should be targeted in the fine-dining restaurants. According to Vaz (2006), plate waste values up to 3% are acceptable in restaurants. However, the author states that each food service must set its reference values, based on its specificities (Carvalho et al. 2015). The least leftovers were observed in food item F2 ($\bar{X}$= 1.15) and the most in food item F9 ($\bar{X}$= 1.82). Taking into account the plate waste of the main dishes, it is noted that 6 food items have a low plate waste while 4 food items have a high plate waste. When these results are included in the classical ME process the following matrix is generated.

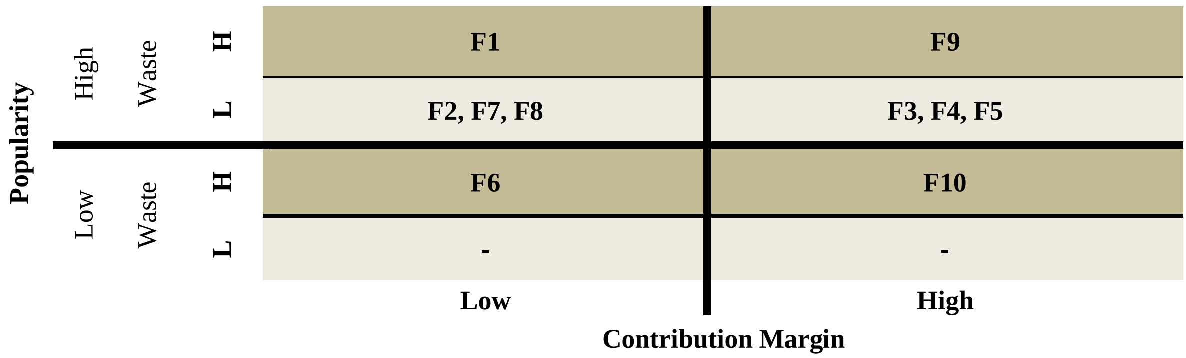

Figure 2. Plate Waste ME Matrix Result

A three-dimensional menu analysis matrix in the form of 2x2x2 was first developed by LeBruto et al. (1995). These authors created a different matrix with eight groups (2x2x2), by including categorical labor costs into the quaternary matrix created by Kasavana & Smith (1982). However, labor costs are closely related to the profitability of menus. Therefore, it is more appropriate to consider it within the contribution margin rather than considering it as a separate dimension. Indeed, in the following years, Raab & Mayer (2007) reflected labor and other operating costs into menu costs using the Activity Based Costing (ABC) method, thus achieving more effective profitability values. Although the labor cost variance used by LeBruto et al. (1995) can be criticized, the idea of developing a classical ME matrix with an additional dimension is considered to be worthwhile. This is because it is possible to make 100% more effective comparisons between menu items by increasing the results of classical ME matrix, which is limited in this regard. Therefore, the eight-matrix matrix developed by LeBruto et al. (1995) was taken as a reference in our study to include the amount of plate consumption in the classical ME process.

As seen in Figure 2, food items F3, F4 and F5 are depicted as the best menu items within the stars. Food items in the star category are profitable, popular and most consumed (least plate waste). For these items, it is generally recommended to strictly maintain their quality and give them a highly visible menu location (Taylor & Brown, 2007). However, plate waste amount of F9 which has been depicted as a star food item is above mean. Hence, managers need to pay more attention to the used materials and cooking methods to reduce the amount of plate waste for this food. The most notable result of the analysis has showed that five food menu items (F1, F2, F7, F8 and F10) need to be improved. For example, according to traditional ME F1, F2, F7 and F8 are classified as Plowhorse items popular but not profitable. That's why most strategies focus on to increase the contribution margin of these items by reducing costs by retooling recipe or increasing the price. Generally, it is not wise to compromise on the quality of food in luxury restaurants. On the other hand, luxury restaurant customers are expected to be less sensitive to food prices. Therefore, first of all it may be thought to increase the prices of foods in this category. Unlike traditional ME results, the results of ME with plate waste provide more meaningful and more detailed information about the relevant menu items. For example, the findings suggest that the content, preparation and cooking processes of the F1 item in Plowhorse category with high plate waste should be reviewed separately. Unlike other foods in this category, this menu item can be edited by reducing the portion size to increase profitability. In the same way, F10 food item with high plate waste in Puzzle group can be examined and the portion quantity and price can be reduced together. Thus, it may be possible to increase the profitability of the related menu item and increase the amount of sales on the other hand.

Depending on the results of the study, it is not correct to say that the menu items with low plate waste are absolutely satisfactory. However, it can be said that the menu items with low amount of plate waste are considered to be relatively more acceptable. Therefore, it is expected that the plate waste level will decrease after the adjustments made on the menu items such as using more quality ingredients, reducing the amount of food stuffs left on the plate, using alternative foodstuffs, using different cooking and serving methods. This can also be considered as an important indicator of the success of the decisions taken regarding the menu. Finally, the results of the research were compared with the results of traditional menu engineering. In this context, as a customers' view, food consumption amount is used instead of popularity and the results obtained are shown in Table 5 below.

Table 5. The Comparison of the Menu Matrix Results

Menu Item	Profit Status	Popularity Status	Consumption Status*	Traditional Menu Matrix Group	The Updated Menu Matrix Group
F1	**Low**	**High**	**Low**	**Plow**	**Dog**
F2	Low	High	High	Plow	Plow
F3	High	High	High	Star	Star
F4	High	High	High	Star	Star
F5	High	High	High	Star	Star
F6	Low	Low	Low	Dog	Dog
F7	Low	High	High	Plow	Plow
F8	Low	High	High	Plow	Plow
F9	**High**	**High**	**Low**	**Star**	**Puzzle**
F10	High	Low	Low	Puzzle	Puzzle

*Food consumption status was determined by the level of plates waste. If the plate waste level is lower than the mean ($\bar{X}$= 1, 42) its consumption status is **High**, If it is not, is **Low**.

The popularity index that is used in traditional method is arise based on the sales quantity of the menu items. However, customers who purchase a menu item may not really like those. Therefore, it is necessary to use the variables that reveal how much each item is actually appreciated by the customers. In this scope, as mentioned before, more robust and more meaningful results can be obtained by using the plate consumption amount (by plate waste analysis) instead of popularity. The food left by the customers on their plates mean that the resources of the enterprise are not used effectively, while on the other hand, they show the demand (sales quantity) of the related menu item is likely to drop.

As can be clearly seen in the Table 5, even a small number of menu items may have significant differences. The F1 menu item in the Plow Group is passed to the Dog group in the admiration index, which is determined by the level of consumption made by the plate analysis. That is, even though the sales quantity of this menu item is above the average values, the consumption level is below the average values. The relatively low consumption of the corresponding menu item means that it is actually less favorable than other menu items. This reveals that especially in the F1 menu item, material, preparation, cooking and residual conditions should be more carefully monitored and reviewed. The same situation applies to the F9 menu item.

Conclusions and Recommendations

In the conducted study it has been concluded that the amount of plate waste is one of the important variables that should be used in evaluating menu performances. At the end of the study, 10 main course items served by a fine-dining restaurant were placed on a matrix consisting of three dimensions (popularity x contribution margin x plate waste) in the form of 2x2x2. Compared to the classical ME results, the main advantage delivered by the acquired results (quaternary matrix) was that the application gave operators the opportunity to carry out more detailed and guest-oriented evaluations. For example, 4 items (F3, F4, F5 and F9) which were qualified as the star foods in the classic ME, were all qualified in the same way. In the three-dimensional ME approach, the F9 menu item differed from the other as a result of the leftover amount. This means that the amount of leftovers in food F9 needs to be reduced in order to enhance guest satisfaction and their intention to come again. In this context, it might be a good idea to attach more importance to the plate arrangement and reconsider the content of the material which comprises the leftovers. On the other hand, at the end of the study it was determined that, in general, the amount of plate waste from the main dish items was rather low (less than 10%). However, the goal that is desired and possible to achieve is to realize near-zero leftovers. On the other hand, even small changes such as 1% in leftover quantities can have remarkable results. Because food waste is not only bad for environment and social perspective, it is also waste of money. It is a conservative estimate that each kg of food waste costs £2 (EPA, 2010). So if a restaurant reduces any food waste while at the same time reducing costs, thus increases its profitability.

Contribution margin, in other words profitability calculations are the most criticized issues in the classic ME approach. Therefore, it is possible to achieve more effective results in future studies if similar three-dimensional analyses are made using more accurate cost and profitability data obtained by advanced costing approaches such as Activity Based Costing (ABC) or Time-Driven ABC. Pirana & Arafat (2014) have stated that ME along with ABC seem to be very effective at reducing food waste, so awareness about these tools needs to be increased. On the other hand, it is also possible that the plate waste is regarded as direct cost variation in the menu analysis process. In this context, a number of improvements can be made by associating plate waste amounts with material costs. For example, the plate size can be changed if the plate waste amount is excessive. It is possible to reduce the amount of leftovers by serving relatively smaller portions on smaller plates.

It is possible to control and reduce food waste by taking plate waste into consideration in the menu analysis process. Therefore, the relevant analysis also contributes positively to the environmental practices of food service businesses. In this context, it is especially recommended for green restaurants.

ME allows to look at the menu from a more detailed and different perspective. Owing to this analysis, very important data about the ideal price, ideal cost and ideal portion of menu items can be obtained. In this context, Menu engineering includes tips on efficient and productive food and beverage management practices in a restaurant business. Besides, many factors such as customer expectations, competition, market trends, and cost inputs, can affect the demand for any food item. Therefore, regardless of how well planned and created, the menus should be evaluated at regular intervals. Menu development is an ongoing process. To provide a competitive advantage, menus must remain flexible. For this reason, menus should be analyzed constantly and periodically, no matter how good they are. Miller (1980) recommends that the menu evaluation process should be applied at least once a month after the opening of the restaurant and at least once in three months after the first year of activity. On the other hand, According to NHS Hospitality (2005), food waste should be recorded for the full duration of the menu cycle or for 14 days where a menu cycle is not used. The findings results should be expressed as a percentage of the total food supplied. Therefore, if plate waste is included in the menu analysis process, it is recommended that analyzes need to be carried out continuously and more frequently (every two weeks or at least once a month). As mentioned earlier, the simple and easy implementation of menu engineering allows the use of this analysis approach with plate waste as desired.

As in any research, there are some limitations in this one. It is not possible to generalize the results of the study since a case study was conducted in a single restaurant operation. On the other hand, it is expected that the waste quantities can change in food service enterprises with different characteristics. In addition, the more plates are evaluated, the more detailed information can be provided. In this context, it is recommended that at least 20 plates to be evaluated for each menu item (Brown, 2007). Plate waste amounts in the study have been taken into consideration as a whole. Therefore, limited information has been acquired for the development of menu item contents. More significant results can be obtained in future studies if the plate waste amount is determined on a material type basis. In fact, it is not correct to say that there is always a valid and robust relationship between the plate waste and the customer satisfaction. Even if customers like the food, they can leave their food on plate the basis of different factors such as being full, health reasons and social factors. In this context, factors such as hunger status, psychology, eating time and accompanying factors may be effective in terms of plate waste amounts. In future studies, the relationship between plate waste and guest attitudes should be tested and factors causing plate waste should be identified. Thus, plate waste information can be used effectively not only in menu management process but also in many business management decisions. Finally, the study by Parsa et al. (2005) found that food quality is important to the success of restaurants; however, there are many more factors that influence success. Restaurant customers in upscale restaurants stay for a much longer time period, making the physical setting another important aspect. Therefore, besides food quality, the restaurant's atmosphere and service quality need to take into consideration in menu evaluation process. Finally, this study covers only the dinner menu items. For more comprehensive assessments, all the foods in the menu must be considered together in future studies.

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