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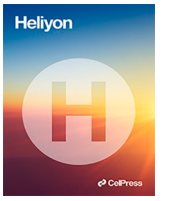

Research article

Using time-driven activity-based costing in restaurant business: Levelled application of a case study

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ABSTRACT

For better profitability, all restaurants should target maximizing workers' productivity, especially in fine dining establishments. In this context, cost knowledge is fundamental information needed for managerial decision-making, such as capacity, pricing, product mix, and profitability analyses. Calculating food costs in recipes can be done easily if only material costs are considered. However, it is quite difficult to associate labor costs and general overhead costs with food production and incorporate them into the calculations. The Time-Driven Activity-Based Costing (TDABC) system is an effective way to calculate the cost of labor based on the time spent by workers during food production. This research applies the TDABC system in a case study conducted in a 5-star luxury hotel's fine dining restaurant to investigate labor cost. Furthermore, it suggests a different approach by enhancing the existing TDABC system formula, which considers workers with different skills and their associated costs (Leveled TDABC). The findings of this research demonstrate that this approach provides more efficient results and allows for a more detailed and effective understanding of idle capacities and labor productivity.

1. Introduction

In the US food service industry, which reached $997 billion and employed 15.5 million people in 2023 [1], 97 % of these restaurants are facing labor problems according to the "State of Restaurants in 2023" report [2]. The report also highlights that food and labor costs are consistently rising, posing significant challenges for restaurateurs. As a result, restaurant businesses need to calculate production costs and manage labor resources in order to make strategic decisions about their dishes [3]. The profitability of the food and its contribution to the overall profitability of the business becomes crucial when determining whether to continue production. To accurately determine profitability and contribution, it is essential to calculate the costs associated with the dishes correctly [4]. With more accurate calculations, management will be able to make more effective decisions about the dishes [5].

Restaurant managers must maximize worker productivity and customer satisfaction while limiting costs. Economic rationality is more important than anything else [6]. In this context, cost knowledge is fundamental information needed for managerial decision-making such as capacity, pricing, product mix, profitability analyses, etc. [7]. Calculating food costs in recipes can be done easily if only material costs are used. However, it is quite difficult to associate labor costs and general overhead costs with food

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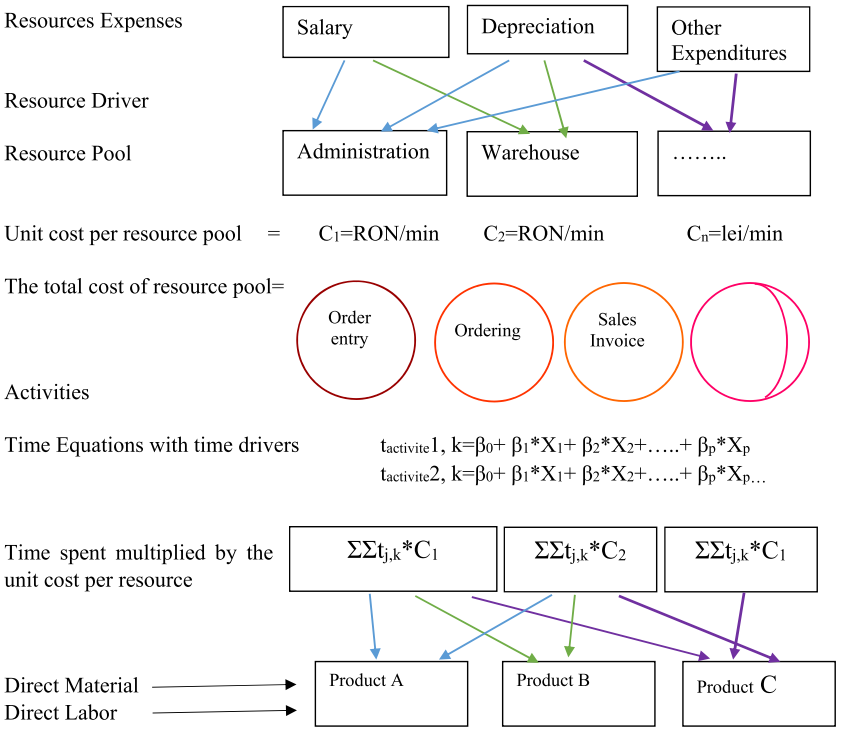
production and involve the calculations [8]. Especially in labor cost calculations, difficulties appear in determining the cost differences caused by non-standard labor usage, differences in work hours, wage differences, and differences in labor qualifications which makes the situation complex. As a result, it becomes difficult to accurately calculate the cost of the produced product ([9,10]; [11]). Although calculations are made to determine labor costs, they may not reflect reality due to the situation. In this context, labor costs and other production-related costs, that appear in food production must be well-analysed and included in production calculations, just as in a manufacturing business [12]. For this reason, an effective cost calculation system must consider all of these factors.

Traditional approaches, as well as contemporary cost calculation systems are frequently used for labor costs. The Activity-Based Costing (ABC) system [9], which was developed due to factors such as changing product and customer structure, technological advancements, and changes in the share of general production expenses in production costs, might applied to almost all sectors. When the system is compared to the traditional ones. All calculations are consumed by activities, and activities are consumed by products and services, and it reveals differences. Considering the shortcomings and disadvantages of the ABC system, Kaplan and Anderson developed the Time-Driven Activity-Based Costing (TDABC) system in 2002 [13]. Although like the ABC system, this system considers the time spent on activities as the cost driver and gives successful results, especially in service enterprises [14].

In addition, using the TDABC system presents a different problem with determining the weight of different skills that have different costs [15]. This issue is not related to most of the articles reviewed, such as French et al.'s [16], Fisher and Krumwiede's [17], or Terence et al.'s (2023) articles because they applied the system in a place where everyone has the same weight of costs. However, if the TDABC operates like Ostadi, Daloie, & Sepehri's [15] or Dalci, Tanis, & Kosan's [18] company, different skills that have different costs could be problematic. Only a few research has pointed this out [19]. Also, Dejnega (2011) conducted a literature review on the application of TDABC. For Dejnega's research all the articles use average labor costs and none of them considers workers with different skills that have different costs.

The aim of the study is to propose suggestions for determining labor costs more accurately in restaurant businesses. In this context,



In the figure

Cost of an individual episode k of an activity j=Tj,k*Ci
C_i= unity cost expressed in minutes of I resources
$T_{j,k}$= time consumed by episode k of j activity
tjk= time necessary to perform episode k or activity j
B_0= the time invariable, independently from the activity characteristics
B_1= Consumption for a driver unit
X_1=time driver 1.....
X_p=time driver p
P=number of drivers that determine the necessary time to perform activity j

Fig. 1. TDABC [26].

Time-Driven Activity-Based Costing (TDABC) system is utilized, which considers the time spent by workers during food production as a cost driver. The cost calculations are applied to a fine-dining à la carte restaurant situated within a 5-star hotel. Furthermore, different approach is proposed by enhancing the existing cost formula, considering workers with different skills and associated costs. These adjustments are based on the chefs' levels and are referred to as Leveled Time-Driven Activity-Based Costing (Leveled TDABC). Strategic recommendations and managerial insights are developed using the data obtained through the implemented model to evaluate the profitability and performance of the dishes.

1.1. Time-driven activity based costing and literature

In the traditional ABC system, there are negative aspects such as difficulty in implementation, high implementation costs, and ignoring the time spent by employees in production [12]. To eliminate these negative aspects, Kaplan & Anderson developed a new costing system in 2003, which can be applied more easily and effectively and uses time as the cost distribution key. With the development of the TDABC system, the number of activities and the collection of information needed from different services were reduced, and cost objects were loaded using unit time instead of different cost drivers [20–22].

The TDABC system consists of two stages. at the first stage, the procurement costs of all resources are calculated, and the resulting costs are divided by the amount of time employees are actively working to determine their unit costs. In the second stage, these unit time costs are multiplied by the total time for each product to obtain the product costs. Essentially, the system is structured through time study and time measurement [12]. These stages are examined under two main headings: installation and cost calculations [23].

During the installation phase, activities are first determined, then the total cost of the resources used in the activities is calculated, followed by the measurement of the total time the workforce spends working on the activities. Finally, the unit time cost is determined by dividing the total activity cost by this time [24]. After the installation phase, the cost calculation phase begins. At this stage, time measurement and estimation of each cost object are performed respectively. After determining the required time for each cost object, the cost amounts to be charged for the products are calculated by multiplying the unit time cost by each activity about calculated time [25].

In the figure.

Cost of an individual episode k of an activity j = Tj,k*Ci.

C_i = unity cost expressed in minutes of I resources.

$T_{j,k}$ = time consumed by episode k of j activity

tjk = time necessary to perform episode k or activity j.

B_0 = the time invariable, independently from the activity characteristics.

B_1= Consumption for a driver unit.

X_1 = time driver 1 …. …

X_p = time driver p.

P = number of drivers that determine the necessary time to perform activity j.

According to Fig. 1, it is necessary to determine the resource expenses required for the execution of the activities. These resource expenses are then allocated to cost pools using resource drivers. The total costs of the resource pool are then divided by the total time using the formula "C_n = lei/min" to determine the cost of each unit of time. Once the time cost of each unit has been determined, the total time required for each activity needs to be calculated. the total time required for the realization of an activity can be found using the formula "$t_{activite}1,k = \beta_0 + \beta_1 * X_1 + \beta_2 * X_2 + \ldots + \beta_p * X_p$ ". Once the total time has been calculated, the unit time cost and the total time are multiplied using the formula "$\Sigma\Sigma tj,k * C_1$" to determine the cost of the relevant activity.

For example, if labor costs are to be calculated using the TDABC system in a restaurant serving an à la carte menu, the time spent by the workforce in the production process of each dish on the menu should be calculated. Then, the labor cost of that dish is found by multiplying it with the average unit time cost of the workforce [27]. Additionally, the productivity of the workforce can be calculated by comparing the time spent on the total manufactured dishes and the total time of the employees at the workplace.

In the research, instead of using TDABC, we will be implementing Leveled TDABC. The primary distinction between the Leveled version of TDABC is its emphasis on the differences in workers' costs and calculating all the various labor costs separately. During the application, it focuses on each station individually and performs micro-calculations. It uses formula $A = (c_i^1 * t_{A,E}^1 + c_i^2 * t_{A,E}^2 + c_i^n * t_{A,E}^n)$ instead of formula $A = c_i * t_{A,E}$

According to Evaraers, Bruggeman, Creus (2019) & Defourny et al. [28], TDABC has some weaknesses. These include difficulties in collecting data, the need to frequently update data and the collection of too many input costs. However, using a computer, working with the systems, and establishing habits can help solve these weaknesses [29]. As seen, the TDABC system is not a temporary solution that can be used; it is a philosophy that companies, hotels, or restaurants must adopt [30].

As a result of the literature review, a small number of articles related to the TDABC in the hospitality sector have been found [29, 31]. Firstly, the TDABC system was first applied in hotels by Dalci, Tanis, & Kosan [18] to make customer profitability analyses. In this study, three costs of the customers were examined with the TDABC system; before they come to the hotels, during their stay, and after they leave the hotel. After comparing the results with the ABC and traditional cost system, the related articles used the average unit cost to determine the unit minute cost in the TDABC application by taking the sum of the salaries of all personnel working in the relevant departments. Similarly, Basuki & Riediansyaf [32] applied the TDABC system in hotels, but only focused on room division. Time studies were carried out regarding the rooms and the labor costs of the room division were calculated by multiplying the time measurements with the averages of the total costs.

Another study by Teringwa [33] in Benue focused on whether to apply the TDABC system in restaurants. As a result of the study,

labor costs can be calculated more accurately and effectively with the TDABC in the restaurant business. However, time measurements made for each food produced in the restaurants showed a variation above the acceptable limits, making it impossible to apply the system in Benue. Also, the result of the study showed that TDABC can only be used in restaurants and hotels that have a good system and qualified labor. Then case study was applied at the hotel in Jogjakarta by Ardinsyah [34]. According to study same as the previous study, TDABC is more efficient and highly accurate in determining the cost of customers. The most recent work belongs to Elshaer [35], which is a case study about analysing restaurant operations with the TDABC and Value Stream Mapping (VSM). Value stream mapping is an approach to identifying activities based on delivering the product value or not to the customers. As a result of the study, TDABC allows the identification of the activities that increase costs and helps optimize the total profit with TDABC, creating value for customers.

As a result of the literature review, many applications of TDABC have been identified. However, most of these applications primarily focus on cost efficiency, and they have been successful in achieving this goal. Only a small number of studies have a specific purpose of contributing to management decisions, such as testing labor productivity. This study, like other research, also emphasizes cost efficiency but adopts a more detailed approach for testing labor productivity.

2. Methodology

TDABC is applied in four stages: preparation, analysis, pilot model application, and feedback. There are some applications that are not clearly defined during the analyses and should be evaluated in their own circle ([12]:67). To observe and evaluate these processes, a case study is seen as an effective method because it is defined as a method to be preferred in situations where the boundaries are not clear, and more than one source of evidence or data is available [36].

It is mentioned that four basic conditions should be increased for clearer and more accurate results in case studies. These conditions are construct validity, internal validity, external validity, and reliability [36]. For Spicer [37] it is stated that the researcher must try different approaches and tactics to achieve more accurate results. In this study, all these conditions and tactics have been applied to obtain better results. Due to the limitation of the articles only main courses have been involved in research. Because the main courses are constituting 53.14 % of total sales and one of the important factors for customers to choosing restaurant.

The selling numbers and material costs of the dishes have been provided by the hotel's accounting department. To calculate these data accounting department has been using the sophisticated software called Material Control (MC) program.

2.1. Problem questions

In the research looking for finding the answers to these questions.

1. The primary distinction between the Leveled version of TDABC is its emphasis on the differences in workers' costs and calculating all the various labor costs separately, in the light of these information during the application of the TDABC system, can the A= ($c_i^1 * t_{A,E}^1 + c_i^2 * t_{A,E}^2 + c_i^n * t_{A,E}^n$) formula gives better results instead of A = $c_i * t_{A,E}$?

Explanation of the formula:
n = Each unit of labor, with differing costs, within a specific time period, A = Cost of event E of activity, $t_{A,E=}$Time required to perform event E of activity A, c_i = cost per time unit of resources [31].

2. As a result of the leveled application, could strategic recommendations and managerial insights be developed, such as a more detailed and effective understanding of idle capacities and labor productivity?

2.2. Restaurant functions and activities

A case study was applied to a fine-dining restaurant located on the 14th floor of a 5-star chain hotel operating in Mersin, which serves as an à la carte service seven days a week. The hierarchy of the cooks is based on the classical Brigade system, which includes a Sous-chef, a Demi-chef, four commis, and a dishwasher. The dishwasher is not in the area all the time during the night and serves the hotel's two kitchens together with the main kitchen. However, he is not included in the calculations because he is not part of food production and preparations.

The restaurant starts operating every day at 3:00 p.m., and customers are starts to accept from 7:00 p.m. Employees make preparations between 3:00 p.m. and 6:00 p.m., which include kneading pita dough, portioning and seasoning meats, preparing foods that need long seasoning and preparation, pre-preparation of salads, chopping cheese varieties, chopping and pre-cooking hot garnishes, pre-preparation of appetizers, chopping and pre-cooking hot vegetables, cleaning fish and seafood varieties, and making seasoning.

2.3. Data collection

All observation-based data was collected between December 13, 2019 and December 27, 2019. The following points were taken into consideration in all measurements; Especially on different days when the business was operating at different intensities, the business was visited more than once. All measurements were repeated on both busy and off-peak days, the preparation times of more than one similar dish from the same table were also measured and included in the calculations considering that the preparation times

would be different, measurements of products such as Beef Wellington which were ordered in very limited numbers were made a limited number of times (2 times). All measurements obtained were used by taking the averages for each product, On days when the density of products such as Mixed Grill is ordered in large numbers every day, the measurements were made again in each order, and their accuracy was tested, the least all recent data, as verified by the Chef de Cuisine of the hotel. All the data was processed using a numerical processing program and tabulated for accuracy.

2.4. The cost of processes and dishes

In this section, we explain how labor costs have been calculated. Table 1 explains the calculation of the per-second labor costs. Table 2 explains the time study of the 25 menu items. For the calculation of the data, entire years are used to reduce the impact of any differentiation. The material costs of the dishes have been calculated by the sophisticated hotel management program.

During the application, all measurements were taken as a second. Therefore, to determine the monthly, daily, and hourly labor costs per second, it is necessary to determine the number of days that employees work actively in a year. Employees are entitled to 15 days of paid leave per year, and they can also take one day off every week for 50 weeks. When we subtract the number of days employees take off from the total number of days in a year, we arrive at the time that employees should be actively working in the business for one year, which is 365 - (50 + 15) = 300 days. To find the monthly total active days, the yearly days have been divided by 12, resulting in 25 active days per month. Each cook is required to work 7 h and 15 min actively every day, which is equivalent to 435 min in total. With this information, the cooks' minute and hourly cost calculations can be determined, as shown in the table below.

Based on the table, there is a difference between the average cost and levelled cost of cooks. The first-level cook is a Sous chef, the second-level cook is a Demi chef, and the third-level cook is a commis. These numbers are calculated based on the labor costs of the menu items. The menu consists of 75 items across 6 different sections. Due to the limitation of the academic article, only the main dishes section has been involved. This section has 25 dishes. All the time studies belonging to main dishes are written in Table 2.

In this table, there are 25 dishes. All the time studies are shown as a second and divided into three sections: 'Preliminary', which includes the tasks before starting the service; 'Preparation', which includes tasks after the orders arrive in the kitchen; and lastly, 'cooking and plating', which includes cooking, baking, and plating.

According to the table, Beef Wellington takes the longest to prepare. Also, it takes high time from second and third-level cooks. Additionally, Beef tenderloin and extra soft veal tenderloin require the most time from the first-level cook. Lamb chops is prepared by only the third-level cook and take the highest time from them. After the determination of the time's study, it's easy to account the yearly active works hours by using the total number of selling dishes.

To make managerial decisions correctly and effectively in a restaurant business, all labor costs must be distributed to the dishes being produced. The measurements conducted only consider the time spent by the workers on each product. In the hospitality sector, there is variability in demand, and there is need to be prepared for service even in the absence of demand. Additionally, although the standards of the work are defined, deviations may occur in the production processes due to factors such as material quality and variability in customer demand. As a result, idle capacity in labor costs occurs within enterprises. The measurements made in the TDABC system indicate this idle capacity. However, more detailed measurements are required to make the managerial decision-making process more accurate and realistic. This way, it can be discovered the level of idle capacities belongs to which level of the cooks, specifically to which employees. Table 3 presents the calculation of the capacity utilization rates resulting from the measurements. For the calculation of the capacity utilization rates used all the menu items shown in Annex-1.

To calculate the total annual hours spent on product usage, multiply the annual selling number of each dish by its corresponding time study result. Collect all the data to determine the annual time spent on each dish, and then compare it to the total annual hours. Repeat this process for all levels of cooks. To calculate the Annual hours spent on product used all items time studies in the ANNEX-1 table.

According to Table 3, second-level cooks have the highest capacity utilization rate. The capacity utilization rates of first and third-level cooks are almost equal. With the capacity utilization rate, all labor costs can be allocated to the dishes. To accurately distribute the idle capacity to labor costs, it should be loaded into dishes and considered when comparing with the TDABC and Leveled TDABC system. The costs associated with the dishes are provided in Table 4.

Table 4 shows the calculation of the labor cost difference between TDABC and Leveled TDABC. According to the table, the average

Table 1
Labor cost calculations (with tax and social security payment).

	Monthly total Wages	Daily cost (monthly cost/25)	hourly cost (daily cost/ 7,25)	per minute cost (hourly cost/60)	per second cost (per minute cost/60)
First Level Cook (1)	$1058	$42.32	$5.8372	$0.09729	$0.0016215
Second Level Cook (1)	$691	$27.64	$3.8124	$0.06354	$0.0010590
Third Level Cook (4)	$645	$25.80	$3.5586	$0.05931	$0.0009885
Average	$721.5	$28.86	$3.9807	$0.06634	$0.0011057
Total Monthly Wages	$4329	**Total Yearly Wages**		$51,948	

Table 2
Time studies of the Main Dishes *(Seconds)*.

Menu Order	Menu Items	Preliminary			Preparation			Cooking and plating			Total			
		1. level cook	2. level cook	3. level cook	1. level cook	2. level cook	3. level cook	1. level cook	2. level cook	3. level cook	1. level cook	2. level cook	3. level cook	Total
41	Burger		104	13	15	10				604	15	114	617	746
42	Grilled Meatball	108		15	20	130	35			541	128	130	591	849
43	Lule Keban			15	25					576	25	0	591	616
44	Grilled chicken leg			70	22					542	22	0	612	634
45	Beyti Kebab			172	25					627	25	0	799	824
46	Lamb Chop			180			150			758	0	0	1088	1088
47	Beef Brisket (Leaf)	24	22		22					558	46	22	558	626
48	Grilled Entrecote	14	5		15				320		29	325	0	354
49	Lamp Chops			36	15					483	15	0	519	534
50	Lamb Loin	31					20		505		31	505	20	556
51	Lamb tenderloin	14	14		23					604	37	14	604	655
52	Veal Tenderloin with the "Ezme" sauce	25	30		25			20	185	181	70	215	181	466
53	Veal tenderloin skewed	20			20				730		40	730	0	770
54	Beef wellington	85	774		25			250		892	360	774	892	2026
55	Thin-cut veal tenderloin			40	20					253	20	0	293	313
56	Extra soft veal Tenderloin	27	32		36			420	75		483	107	0	590
57	Beef Tenderloin	25	30		34			420	75		479	105	0	584
58	Plank tenderloin	23	25		82					853	105	25	853	983
59	Cranks tenderloin	21	25		63					587	84	25	587	696
60	Tenderloin Provencal style				48					317	48	0	317	365
61	Special Lamb Grill	22			42	30		300			364	30	0	394
62	Chateaubriand	21						72		543	93	0	543	636
63	Special veal pan			48				50		496	50	0	544	594
64	Veal with Cafe de Parie sauce				43					723	43	0	723	766
65	Mixed grill (for 2 people)				22	130				675	22	130	675	827

Table 3
Capacity utilization rate.

	Monthly total work hours	Annual total work hours	Annual Total Hours Spent on Products	Capacity Utilization Rate
First Level Cook	181.25	2175	414.1	19.04 %
Second Level Cook	181.25	2175	1541.9	70.89 %
Third Level Cook	725	8700	1707.5	19.63 %
Total	1087.5	13050	3663.5	28.07 %

Table 4
Yearly and per meal Cost calculation based on the TDABC and Leveled TDABC.

		Yearly total sell num.	Leveled TDABC labor cost ($)	TDABC labor cost ($)	Leveled TDABC with idle capacity ($)	TDABC with idle capacity ($)	Leveled TDABC Yearly ($)	TDABC Yearly ($)	Percentage difference per dishes
41	Burger	624	0.75	0.82	3.41	2.94	2125.07	1833.53	15.90 %
42	Grilled Meatball	675	0.93	0.94	4.26	3.34	2876.14	2257.23	27.42 %
43	Lule Keban	245	0.62	0.68	3.19	2.43	781.43	594.45	31.45 %
44	Grilled chicken leg	141	0.64	0.70	3.27	2.50	461.03	352.11	30.93 %
45	Beyti Kebab	230	0.83	0.91	4.24	3.25	974.53	746.48	30.55 %
46	Lamb Chops	102	1.08	1.20	5.48	4.29	558.93	437.11	27.87 %
47	Beef Brisket (Leaf)	387	0.65	0.69	3.24	2.47	1251.95	954.22	31.20 %
48	Grilled Entrecote	724	0.39	0.39	0.73	1.39	530.32	1009.50	47.47 %
49	Lamp Chops	702	0.54	0.59	2.74	2.10	1924.67	1476.53	30.35 %
50	Lamb Loin	394	0.60	0.61	1.12	2.19	440.94	862.85	48.90 %
51	Lamb tenderloin	487	0.67	0.72	3.38	2.58	1645.13	1256.42	30.94 %
52	Veal Tenderloin with the "Ezme" sauce	117	0.52	0.52	1.83	1.84	213.99	214.75	0.35 %
53	Veal tenderloin skewed	112	0.84	0.85	1.43	3.03	160.29	339.68	52.81 %
54	Beef wellington	18	2.29	2.24	8.71	7.98	156.87	143.64	9.21 %
55	Thin-cut veal tenderloin	136	0.32	0.35	1.65	1.23	223.86	167.67	33.51 %
56	Extra soft veal Tenderloin	43	0.90	0.65	4.27	2.32	183.77	99.93	83.90 %
57	Beef Tenderloin	2146	0.89	0.65	4.24	2.30	9091.66	4936.37	84.18 %
58	Plank tenderloin	305	1.04	1.09	5.23	3.87	1594.47	1180.91	35.02 %
59	Cranks tenderloin	127	0.74	0.77	3.71	2.74	471.07	348.16	35.30 %
60	Tenderloin Provencal style	192	0.39	0.40	2.01	1.44	385.04	276.03	39.49 %
61	Special Lamb Grill	67	0.62	0.44	3.15	1.55	210.72	103.98	102.66 %
62	Chateaubriand	143	0.69	0.70	3.53	2.51	504.35	358.23	40.79 %
63	Special veal pan	50	0.62	0.66	3.17	2.34	158.29	116.98	35.31 %
64	Veal with Cafe de Parie sauce	236	0.78	0.85	4.01	3.02	945.80	712.04	32.83 %
65	Mixed grill (for 2 people)	2003	0.84	0.91	3.78	3.26	7573.75	6524.57	16.08 %
	Total Difference 10,303.17 $					**Average Percentage difference**			**38.18 %**

difference of the dishes is 38.18 % and the total difference of the cost is $10,303.17. Special Lamb Grill has the highest difference percentage, while Ezme Sauce has the lowest. Additionally, the highest-selling meal, Beef Tenderloin, has the highest yearly difference, which amounts to $4155.28. Almost all the dishes' labor costs have significant differences between TDABC and Leveled TDABC. These costs are using the calculation of the contribution margin to the dishes. Table 5 shows the calculation differences of the contribution margin using TDABC and Leveled TDABC.

To calculation of the Leveled TDABC with idle capacity and TDABC with idle capacity of the menu items all the levels of cook own capacity utilization rate has been used. example calculating of the burgers labor cost of Leveled TDABC with idle capacity.

First level cook working 15 s, second level cook 114 s and third level cook 617 s.

Calculation of the first level cook = (15 s x $0.0016215)/19.04 %

Calculation of the second level cook = (114 s x $0.0010590)/70.89 %

Calculation of the third level cook = (15 s x $0.0009885)/19.63 %

Then collecting the three results (0.127757 + 0.170292 +3.107517) = 3.40556.

For TDABC with idle capacity (15 + 114+617) = 746.

Calculation of the TDABC (746 × $0.0011057)/28.07 % = 2.938354.

Table 5 shows the calculation of the contribution margin for the dishes. All material costs have been calculated using the MC program. Normally, the contribution margin is found by subtracting the variable cost from the selling price. However, in this situation,

Table 5
Calculation of the contribution margin to the meal based TDABC and Leveled TDABC.

		Sel. price ($)	Mat. cost ($)	Labor cost by Leveled TDABC with idle capacity	Labor cost by TDABC with idle capacity	Cont. Margin for Leveled TDABC	Cont. Marg. for TDABC	Difference
41	Burger	9.27	2.53	3.41	2.94	3.33	3.80	0.47
42	Grilled Meatball	10.11	1.84	4.26	3.34	4.01	4.93	0.92
43	Lule Keban	10.11	1.93	3.19	2.43	4.99	5.75	0.76
44	Grilled chicken leg	10.96	1.24	3.27	2.50	6.45	7.22	0.77
45	Beyti Kebab	10.96	2.10	4.24	3.25	4.62	5.61	0.99
46	Lamb Chops	11.80	2.36	5.48	4.29	3.96	5.15	1.19
47	Beef Brisket (Leaf)	11.80	3.02	3.24	2.47	5.54	6.31	0.77
48	Grilled Entrecote	13.48	3.00	0.73	1.39	9.75	9.09	−0.66
49	Lamp Chops	13.48	3.75	2.74	2.10	6.99	7.63	0.64
50	Lamb Loin	13.48	2.62	1.12	2.19	9.74	8.67	−1.07
51	Lamb tenderloin	14.33	4.65	3.38	2.58	6.30	7.10	0.80
52	Veal Tenderloin with the"Ezme" sauce	14.33	4.74	1.83	1.84	7.76	7.75	−0.01
53	Veal tenderloin skewed	15.17	4.31	1.43	3.03	9.43	7.83	−1.60
54	Beef wellington	15.17	6.61	8.71	7.98	−0.15	0.58	0.73
55	Thin-cut veal tenderloin	15.17	3.36	1.65	1.23	10.16	10.58	0.41
56	Extra soft veal Tenderloin	15.17	5.14	4.27	2.32	5.76	7.71	1.95
57	Beef Tenderloin	15.17	4.99	4.24	2.30	5.94	7.88	1.94
58	Plank tenderloin	15.17	4.61	5.23	3.87	5.33	6.69	1.36
59	Cranks tenderloin	15.17	5.11	3.71	2.74	6.35	7.32	0.97
60	Tenderloin Provencal style	15.17	4.42	2.01	1.44	8.74	9.31	0.57
61	Special Lamb Grill	15.17	4.24	3.15	1.55	7.78	9.38	1.59
62	Chateaubriand	16.01	5.24	3.53	2.51	7.24	8.26	1.02
63	Special veal pan	16.01	3.35	3.17	2.34	9.49	10.32	0.83
64	Veal with Cafe de Parie sauce	16.01	4.43	4.01	3.02	7.57	8.56	0.99
65	Mixed grill (for 2 people)	23.60	6.63	3.78	3.26	13.19	13.71	0.52

material cost and labor cost are considered as variable costs. To calculate the contribution margin of each meal, the material cost and labor cost are subtracted from the selling prices using the formula: Contribution margin = Selling price – (Material cost + Labor cost). According to the table, using Leveled TDABC and TDABC makes a significant difference in the calculation of the contribution margin. Extra Soft Veal Tenderloin and Beef Tenderloin show the largest differences. Beef Tenderloin is the most selling dishes in the main dishes section.

As seen in Tables 4 and 5, the TDABC system is very effective in determining labor costs. It also provides the opportunity to understand the efficiency of the labor when the system is applied to each level separately. Also Leveled version of the TDABC gives more accurate result then the traditional TDABC.

3. Result

In the article, we are looking for answers the two questions. The first question is: "Application of the TDABC system, can the $A=(c_i^1*t_{A,E}^1+c_i^2*t_{A,E}^2+c_i^n*t_{A,E}^n)$ formula gives better results instead of $A = c_i*t_{A,E}$?" The result of the calculations takes into account workers with different skills, associated costs, and the level of effectiveness of chefs. Based on the case study using Leveled TDABC, according to Table 4, the result is $10,303.17, with a 38.18 % difference in the main dishes section. When compared to yearly wages, this difference is significant. The calculation of the contribution margin in Table 5 also shows an important difference.

For Teringwa [33], using the TDABC system allowed the calculation of labor costs more effectively. When comparing the results of the studies by Dalci, Tanis, & Kosan [18], Dejnega [31] and, Siguenza-Guzman et al. [29], who used TDABC, it is evident that Leveled TDABC provides more effective results. None of these studies considered workers with different skills and associated costs during the calculation. According to Adiguzel & Floros (2020), TDABC is a philosophy worth adopting. If the adoption process is not applied more effectively, it would affect managerial decisions incorrectly.

The second question addressed in this study is: "To gain a more detailed and effective understanding of idle capacities and labor productivity, can Leveled TDABC be used?" As a result of the research, time studies were applied based on different skills and worker costs, enabling the calculation of idle capacity at varying levels of labor. The study revealed that the capacity utilization rates for first and third-level cooks are remarkably low, with the first-level cooks operating at 19.04 % and the third-level cooks at 19.63 %. In contrast, second-level cooks demonstrate a more efficient capacity utilization rate of 70.89 %. While first-level cooks bear some responsibility for managing the restaurants, it is imperative that the capacity utilization rates for third-level cooks be increased, as their inefficiency could potentially lead to bottlenecks.

During the case study, several bottlenecks were observed. Additionally, the sous chef requested management to hire additional third-level cooks. After sharing the study's results with the restaurant management, they decided to reduce the number of third-level cooks from four to two and hired second-level cooks. Following feedback from management, and after two months of implementing these changes, all bottlenecks in the cooking process decreased. Taking the calculations and feedback into account, a positive answer to the second question became evident.

According to Evaraers, Bruggeman, Creus (2019) and Defourny et al. [28], the difficulty of calculation and data collection is the weakness of TDABC. However, nowadays it is easier and allows for more detailed analysis due to the development of technology. Implementing TDABC while considering workers' different skills and associated costs would be more effective and could provide more information to the management of the restaurant.

4. Limitation and future studies

The study was conducted in a restaurant that operates a la carte service. It should be noted that the findings may vary in businesses that prefer a different service style or have different cost-to-sales ratios. Additionally, restaurants with a smaller number of products on their menu may also exhibit different outcomes. To obtain more precise and comprehensive results, future studies should encompass businesses with diverse characteristics.

TDABC could be used for all the cost drivers, but the hotel management only shared and allowed access to certain data. As a result, the research is primarily focused on labor costs and excludes other expenses such as depreciation, rent, energy, etc. also this situation imposes limitations on the research. These data can be involved to the future research.

Data availability statement

The data that support the findings of this study are available in Annex 1. Further information can be requested from the corresponding author.

CRediT authorship contribution statement

Kemal Enes: Writing – review & editing, Writing – original draft, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Levent Koşan:** Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Annex 1.

Time studies of all menu items

					Preliminary (Seconds)			*Preperations (Seconds)*			*Cook and Plating (Seconds)*			*Total (Seconds)*				*Yearly Total (Annual num. x total meas. time)*			
	Menu items	Selling price	Material Cost	annual number of sales	1. level cook	2. level cook	3. level cook	1. level cook	2. level cook	3. level cook	1. level cook	2. level cook	3. level cook	1. level cook	2. level cook	3. level cook	Total	1. level cook	2. level cook	3. level cook	Total Yearly
1	Ezine chese plate	4.72	0.76	1373					80					0	80	0	80	0	109840	0	109840
2	Smoked Salmon	5.90	2.48	103					180					0	180	0	180	0	18540	0	18540
3	Export cheese on the wooden plate	6.74	2.75	567		60			120					0	180	0	180	0	102060	0	102060
4	Traditional Anatolian cheese on the wooden plate	6.74	1.22	70		60			140					0	200	0	200	0	14000	0	14000
5	Delicatessen products on wooden plate	12.64	3.66	89			240		250					0	250	240	490	0	22250	21360	43610
6	Provincial style Potato chips	3.37	0.07	376			40		10				300	0	10	340	350	0	3760	127840	131600
7	Lebanese style stuffed meatballs	4.72	1.06	641					20			145		0	165	0	165	0	105765	0	105765
8	Stuffed Mushroom	4.72	1.35	746		6	25					420		0	426	25	451	0	317796	18650	336446
9	Grilled Halumi	4.72	1.41	275			20	20					220	20	0	240	260	5500	0	66000	71500
10	Humus with pastrami	4.72	1.01	1681			50		260			45		0	305	50	355	0	512705	84050	596755
11	Crypsy Turkish mantı	5.90	1.03	160			30	20				120		20	120	30	170	3200	19200	4800	27200
12	Georgian Mantı	5.90	1.53	54			270					180		0	180	270	450	0	9720	14580	24300
13	Sauted Squid	6.74	1.98	855			90			60		240		0	240	150	390	0	205200	128250	333450
14	Arayes	6.74	1.28	69				30	30	120		380		30	410	120	560	2070	28290	8280	38640
15	Prawn Casserole	7.58	2.29	480			20					690		0	690	20	710	0	331200	9600	340800
16	Turkish Haydari	3.71	0.24	426		30			20					0	50	0	50	0	21300	0	21300
17	Sauced potato chips	3.71	0.34	917		40				15			190	0	40	205	245	0	36680	187985	224665
18	Turkish meses "kopğlu"	3.71	0.19	396		90			11					0	101	0	101	0	39996	0	39996
19	Turkish Börülce	3.71	0.48	190		10			12					0	22	0	22	0	4180	0	4180
20	Turkish Tarator with tahini	3.71	0.35	225		120			13					0	133	0	133	0	29925	0	29925
21	Turkish Atom mezes	3.71	0.24	1234		15			25					0	40	0	40	0	49360	0	49360
22	Greek mezes	3.71	0.13	18		120			10					0	130	0	130	0	2340	0	2340
23	Turkish meat mezes with purslane	3.71	0.67	146		135			25					0	160	0	160	0	23360	0	23360
24	Createn mezes	3.71	0.48	221		19			10					0	29	0	29	0	6409	0	6409
25	Sour Pepper	3.71	0.07	332		160			10					0	170	0	170	0	56440	0	56440
26	Cold Keşkek	3.71	0.18	46		120			25					0	145	0	145	0	6670	0	6670
27	Tzakziki	3.71	0.31	755		15			30					0	45	0	45	0	33975	0	33975
28	Lebanese hot mezes	3.71	0.15	143		32			10					0	42	0	42	0	6006	0	6006
29	Turkish Muhammara	4.21	1.03	482		8			10					0	18	0	18	0	8676	0	8676
30	Spanish Tapas	4.21	0.94	69					90	220		10		0	100	220	320	0	6900	15180	22080
31	Octopus salad	5.90	2.42	95		20								0	20	0	20	0	1900	0	1900
32	special rakı mezes	13.48	1.62	529		195			40			145		0	380	0	380	0	201020	0	201020
33	Special Salad	4.72	0.35	1420		30			134					0	164	0	164	0	232880	0	232880
34	Shepperd salad	4.72	0.41	566		40			120					0	160	0	160	0	90560	0	90560
35	Aragula salad	4.72	0.23	341		90			87					0	177	0	177	0	60357	0	60357
36	Mediterenian salad	4.72	0.85	1875		30			50					0	80	0	80	0	150000	0	150000
37	Turkish Goçmen salad	4.72	0.43	105		90			50					0	140	0	140	0	14700	0	14700
38	Turkish hot "gavurdağı salad"	4.72	0.37	664		70			35					0	105	0	105	0	69720	0	69720
39	Fettush	4.72	0.43	74		30			170					0	200	0	200	0	14800	0	14800
40	Tuscany Salad	5.06	1.67	199		30			170					0	200	0	200	0	39800	0	39800
41	Burger	9.27	2.53	624		104	13	15	10				604	15	114	617	746	9360	71136	385008	465504
42	Grilled Meatball	10.11	1.84	675	108		15	20	130	35			541	128	130	591	849	86400	87750	398925	573075
43	Lule Keban	10.11	1.93	245			15	25					576	25	0	591	616	6125	0	144795	150920
44	Grilled chicken leg	10.96	1.24	141			70	22					542	22	0	612	634	3102	0	86292	89394
45	Beyti Kebab	10.96	2.10	230			172	25					627	25	0	799	824	5750	0	183770	189520
46	Lamb Chops	11.80	2.36	102			180			150			758	0	0	1088	1088	0	0	110976	110976
47	Beef Brisket (Leaf)	11.80	3.02	387	24	22		22					558	46	22	558	626	17802	8514	215946	242262
48	Grilled Entrecote	13.48	3.00	724	14	5		15				320		29	325	0	354	20996	235300	0	256296

49	Lamp Chops	13.48	3.75	702			36	15					483	15	0	519	534	10530	0	364338	374868
50	Lamb Loin	13.48	2.63	394	31					20		505		31	505	20	556	12214	198970	7880	219064
51	Lamb tenderloin	14.33	4.66	487	14	14		23					604	37	14	604	655	18019	6818	294148	318985
52	Veal Tender loin with the "Ezme" sauce	14.33	4.75	117	25	30		25			20	185	181	70	215	181	466	8190	25155	21177	54522
53	Veal tenderloin skewed	15.17	4.31	112	20			20				730		40	730	0	770	4480	81760	0	86240
54	Beef wellington	15.17	6.61	18	85	774		25			250		892	360	774	892	2026	6480	13932	16056	36468
55	Thin cut veal tenderloin	15.17	3.37	136			40	20					253	20	0	293	313	2720	0	39848	42568
56	Extra soft veal Tenderloin	15.17	5.15	43	27	32		36			420	75		483	107	0	590	20769	4601	0	25370
57	Beef Tenderloin	15.17	4.99	2146	25	30		34			420	75		479	105	0	584	1027934	225330	0	1253264
58	Plank tenderloin	15.17	4.62	305	23	25		82					853	105	25	853	983	32025	7625	260165	299815
59	Cranks tenderloin	15.17	5.11	127	21	25		63					587	84	25	587	696	10668	3175	74549	88392
60	Tenderloin provencale style	15.17	4.43	192				48					317	48	0	317	365	9216	0	60864	70080
61	Special Lamb Grill	15.17	4.25	67	22			42	30		300			364	30	0	394	24388	2010	0	26398
62	Chateubriand	16.01	5.24	143	21						72		543	93	0	543	636	13299	0	77649	90948
63	Special veal pan	16.01	3.35	50			48				50		496	50	0	544	594	2500	0	27200	29700
64	Veal with Cafe de parie sauce	16.01	4.44	236				43					723	43	0	723	766	10148	0	170628	180776
65	Mixed grill (for 2 person)	23.60	6.63	2003				22	130				675	22	130	675	827	44066	260390	1352025	1656481
66	Grilled Salmon	11.80	3.31	785		90		30				380		30	470	0	500	23550	368950	0	392500
67	Grilled seabass	11.80	2.70	682			70	60					344	60	0	414	474	40920	0	282348	323268
68	Grill octopus	11.80	4.99	274			140	30					300	30	0	440	470	8220	0	120560	128780
69	Ice cream	3.37	0.39	159						30				0	0	30	30	0	0	4770	4770
70	Turkish Sütlaç	4.21	0.33	3					120					0	120	0	120	0	360	0	360
71	Profitoreles	4.21	0.95	280						180				0	0	180	180	0	0	50400	50400
72	Turkish Katmer	5.06	1.45	509					10				700	0	10	700	710	0	5090	356300	361390
73	Souffle	5.06	1.04	402									480	0	0	480	480	0	0	192960	192960
74	Rococo	5.06	0.65	713						90				0	0	90	90	0	0	64170	64170
	Season Fruits	5.06	0.64	3227			30		290					0	290	30	320	0	935830	96810	1032640

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