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An Application of Time-Driven Activity Based Costing Method in the Mold Manufacturing Industry

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Abstract

Purpose: The purpose of this study is to analyze in detail one of the new cost approaches, time driven activity-based costing (TDABC), and in this context the cost of a mold manufacturing company is analyzed.

Methodology: For this research, we used primary and secondary sources. Direct observation, interviews with relevant departments and computer analysis methods were used as data collection method. A software and online database especially developed for the project was used in order to ease data collection.

Findings: Different than traditional volume-based cost methods, with TDABC, based on data analysis, we have identified idle capacities for each department. Which means, TDABC method can be used as an effective management tool as well as for financial reporting purposes.

Originality/Value: This paper aims to provide empirical evidence in the implementation of TDABC in project-based manufacturing industry, especially in mold sector and give a contribution to researchers in this field.

1. Introduction

Control and management of costs in enterprises has gained much more importance today compared to the past, due to the increase in competition. For this reason, enterprises are making more efforts to choose a cost management method suitable for their production systems to manage their costs more effectively. Activity Based Costing (ABC), which is a very common option in this regard, has provided important advances in terms of cost control and management by focusing on activities as a cost driver in the distribution of indirect expenses. ABC has a two-stage distribution structure which accepts that activities consume resources and cost elements consume activities.

Over time, the ABC method has been criticized for various reasons such as measurement errors, high installation and update costs. Time-Driven Activity Based Costing (TDABC) method appears as a method developed in order to provide solutions to these criticisms. TDABC method stands out with its ease, especially in terms of capacity control while preserving the basic features of the ABC method. The most important feature of the TDABC method is that it uses time equations as a management tool.

The main goal of this study is to reveal the advantages and disadvantages of TDABC by comparing the results obtained of applying TDABC method to the enterprises that conduct order or project-based production with the traditional method. In the literature on this subject, studies on companies conducting mass production or having standard processes in the service industry are found in general. For this purpose, TDABC method was applied on a company producing pipe fitting molds for plastics industry. With this study, it will be better revealed how the application of TDABC in an industrial enterprise that conducts order-based production affects capacity utilization and production costs.

2. Time-Driven Activity Based Costing

Enterprises discovered ways to both increase profitability and manage costs more effectively in ABC applications especially during 90s, and gained highly significant benefits with this way (Yilmaz and Baral, 2007: 3).

Emergence of certain deficiencies of the traditional ABC method over time has caused many enterprises to abandon this method or start to apply it at a limited level (Kaplan, 2005: 13). In particular, reasons such as application and update difficulty, causing increase in costs, dissatisfaction of employees, difficulties in capacity calculation and inconsistent results have led enterprises to stop using the ABC method (Kaplan and Anderson, 2005: 131-132).

TDABC method has been developed in response to abovementioned criticism and needs. It is especially emphasized that it has been developed by taking the benefits obtained from ABC into consideration. TDABC method stands out with its easy and fast application, easy integration with systems such as ERP and CRM, its advantages in terms of sustainability and cost, and its rapid update abilities. Its ability to predict orders and resource demands more transparently in terms of modeling, efficiency and capacity utilization operability is also considered among other features (Kaplan and Anderson, 2003: 15-16).

It is thought that TDABC method takes time as the basic measure in the performance of activities, produces more effective information in terms of management since it does not include the empty capacity in the cost calculation (Özyürek and Dinç, 2014: 350).

3. Method of The Research

The application was carried out at a private enterprise in Istanbul, Turkey, producing molds for plastic industry. The company produces plastic pipe fittings and electrical material molds. The company carries out order-based production and a total of 13 workers are employed by the company's production department.

Purpose of this study is to compare the results of application of TDABC method in this enterprise carrying out order-based production with volume-based costing method which is currently used by the enterprise. Cost information for raw material and conversion (workmanship and general production expenses) required for the operation was obtained from the accounting department. Order-based cost information was obtained from the planning department. TDABC application in the operation was performed by based on conversion costs. Raw material cost was considered in calculation of total order cost. The application includes the actual data for January – March 2016, and the company has performed the production of 32 mold orders in this time period. Direct observation, interviews with relevant departments and computer analysis methods were used as data collection methods. A software and online database specifically developed within the scope of the project was used in order to ease data collection.

4. Application

In the study, following 6-stage procedure was used in TDABC for the company carrying out mold production for plastic industry (Everaert and Bruggeman, 2017: 17).

- Determination of resource groups
- Determination of costs belonging to resource groups
- Determination of practical capacity of each resource group
- Calculation of capacity cost rate for each resource group
- Determination of costs assigned to each resource group
- Calculation of total costs assigned to resource groups

4.1. Determination of Resource Groups

As a result of observations and interviews, it has been determined that production department of the enterprise consisted of five resource groups as Planning, CNC, Other Machining Processes, Assembly and Delivery. These resource groups are to be called as departments and their main activities are shown in the table below.

Table 1: Resource Groups of the Enterprise and Their Activities

Resource Groups	**Production Processes**			
Planning	CAD Programming	CAM Programming		
CNC	CNC Processing	CNC Lathe		
Other Machining Processes	Borwerk Cutter	Manual Lathe	Erosion	Peck Drilling Process
Assembly	Mold Lapping	Mold Assembly		
Delivery	Test Process	Painting	Packing	

4.2. Determination of Costs Belonging to Resource Groups

When determining expense types of the enterprise, data for January-March 2016 period was obtained from the accounting department. In the study, conversion costs were analyzed, costs other than raw material and production were not taken into consideration. Following table shows direct workmanship and general production expenses (conversion costs) other than direct raw material and articles as well as the cost drivers determined by us.

Table 2: Conversion Costs and Cost Drivers

Actual Conversion Costs	Amount (TRY)	Cost Share	Cost Driver
Personnel Wage	103,935	30.6%	Direct
SSI Employer Share	21,930	6.5%	Direct
SSI Employee Unemployment	2,027	0.6%	Direct
Notice Pay	1,110	0.3%	Direct
Operation Costs	22,704	6.7%	In Proportion Among Departments Used
Repair and Maintenance Expenses	12,238	3.6%	Equal Among Departments Using Machines
Workmanship, Cutting, Marking, Trial Expenses	32,264	9.5%	Number of Order
Electricity Expenses	6,584	1.9%	Number of Machines
Food and Kitchen Expenses	9,394	2.8%	Number of Personnel
Shipment and Cargo Expenses	2,490	0.7%	Equal Among Departments
Personnel Transportation Expenses	12,435	3.7%	Number of Personnel
Rent Expenses	60,000	17.6%	m2
Work Clothes and Component Expenses	1,488	0.4%	Number of Personnel
Machinery Amortization Expenses	33,900	10.0%	Direct
Fixture Amortization Expenses	433	0.1%	Direct
Vehicle Amortization Expenses	13,734	4.0%	Equal Among Departments
Various Expenses	3,314	1.0%	Equal Among Departments
	339,980	100.0%	

Conversion costs of January-March period of the enterprise were distributed to relevant departments via the distribution keys determined above. When distribution keys are determined, the departments where cost is created were taken into consideration. For instance, personnel expenses were directly distributed taking into consideration the wages of personnel working at the relevant department while m^2 measurement was preferred for rent expenses. Table 3 shows the expense shares of the production department.

Table 3: Costs of Resource Groups After Distribution of Conversion Costs

Resource Groups	Conversion Costs (TRY)
Planning	60,439
CNC	114,409
Other Machining Processes	56,343
Assembly	76,464
Delivery	32,324
	339,980

4.3. Determination of Practical Capacity for Each Resource Group

Practical capacity is the production amount realized under the design capacity (design capacity is defined as the highest level of production amount expected to be realized under ideal conditions determined during design stage of the system) due to current environmental conditions and various disruptions occurred during the production (Kobu, 2008: 243-244). When practical capacity is determined, different capacity scales such as number of workers, machine operation hours for each resource group can be used. In this study, it was deemed suitable to use number of (mold) workers since the enterprise subject to the application conducted activities in a labour-intensive industry. When calculation is performed, practical capacity was calculated based on the theoretical capacity that is daily working hours of workers. In the enterprise of application, daily working hours is 9 and there is 1 hour of lunch break and two tea breaks, each lasting 15 minutes. In the light of these information and considering other needs of workers and quality of the work, it was deemed suitable to consider practical working hours 7 hours a day.

4.4. Determination of Capacity Cost Rate for Each Resource Group of the Enterprise

Number of worked days for January-March period of 2015 were calculated as 63. When capacity-cost rate was determined, total cost of each resource group is divided to practical capacity (Kaplan and Anderson, 2007:6). Following table calculates capacity-cost rates separately for each resource group.

Table 4: Capacity Cost Rates of Production Resource Groups

Departments	Number of Personnel	Practical Capacity (Hours) (63x7)	Total Practical Capacity (Hours)	Total Expense Share (TRY)	Capacity Cost-Rate (TRY/Hour)
Planning	4	441	1,764	60,439	34.26
CNC	4	441	1,764	114,409	64.86
Other Machining	1	441	441	56,343	127.76
Assembly	3	441	1,323	76,464	57.80
Delivery	1	441	441	32,324	73.30
Total	13		5,733		

4.5. Determination of Costs Assigned to Each Resource Group of the Enterprise

TDABC method uses “time equations” to determine capacity utilizations of orders. These equations are created by combining various different activities. It has been accepted that these are important and beneficial tools for revealing the duration of production process. It is quite easy for enterprises to clearly determine their production processes to prepare these equations (Kaplan and Anderson, 2007:34). With this feature, TDABC method differs from traditional ABC method. Updating the process and duration is easy thanks to the interventions to be made on the equation.

Creation of time equations for industries making order-based production as in this study such as mold industry is a little more difficult compared to enterprises making standard production. Each new order being different from each other requires developing special time equations for each order. It is especially important to identify the factors affecting time in work analysis.

In the equation given below, the time required to carry out (k) event of (j) activity is explained by (x) drivers in (p) time. (Bruggeman et al., 2005: 12-13; Everaert and Bruggeman, 2007: 17)

$t_{jk} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p$

According to features of activities of a production process, the total duration consumed (t_{jk}) is expressed with functions involving time drivers' variables.

β_0 means a constant time and is independent from activity features.

β_1 shows the increase in duration for one unit of increase in x_1. Parameters in the equation are explained as follows.

t_{jk} = the duration required to carry out (k) event of (j) activity,

β_0 = constant duration required for (j) activity,

β_1 = duration consumed for one unit of time factor no.1 when x_2, x_3, x_4, ... x_p is constant,

x_1 = time factor 1, x_2 = time factor 2, ..., x_n = time factor n

P = number of time factors used to determine the duration required for (j) activity performed.

Let us assume that order process is based on three-time drivers as customer type (old/new), number of data entries (number of request entries) and order type (normal/urgent). With the assumption that basic order information entry takes 5 minutes, each data entry requires 3 minutes and also new customer information entry requires 20 minutes, and additional 7 minutes are required if the order is urgent;

Processing duration per order = $5 + 3x_1 + 20x_2 + 7x_3$

x_1 = Order processing (request entry) number,

x_2 = (0) for available customer and (1) for new customer,

x_3 = (0) for normal order and (1) for urgent order.

Therefore, order processing time required in the event of 5 urgent orders for a new customer would be (t_{jk}) = 5 + 3x5 + 20x1 + 7x1 = 47 minutes.

After determination of amounts of time drivers, amounts of time drivers are put in the time equation in order to find the total durations requested for each resource group. Afterwards, the duration required for each resource group is multiplied by capacity-cost rate to calculate the costs assigned to orders from resource groups.

Application stages of this process exemplified above in our study are shown below. Definition of a mold, determination of its production processes and determination of factors causing difference in terms of time in the production process is important in terms of time equations in mold production.

Based on observations and interviews, factors affecting production process of a mold are listed below. It was coded as time factor similar to the example given above to be used in time equations.

x_1 = The fact that the mold was produced previously

x_2 = Modification requirement of the mold

x_3 = Mold complexity coefficient (difficulty level 1-5)

x_4 = Number of mold mesh

x_5 = Surface area of the mold

x_6 = Borwerk process requirement of the mold

x_7 = Hot runner technology utilization on the mold

x_8 = Number of tests conducted on the mold

x_9 = Painting of the mold

Durations required to create time equations of the mold order and amounts of drivers required for each process were determined considering the factors listed above. Activities such as heat treatment, sanding, chromium plating performed by contractor outside the enterprise were not included in the process.

Time equation of planning department

Activities required to create time equations at planning department and their durations are shown below.

Table 5: Planning Department Processes and Time Drivers

Processes	Sub-Processes	Process Activities	Time Drivers	Duration (hours)
Order Acceptance	Order Acceptance	Order Entry	Registration Form	3
Drawing	New Drawing	Design	Registration Form	8
	Updating the Previous Drawing	Update	Registration Form	1
	Modification Process	Update	Registration Form	4
	Complexity Coefficient (1-5)	Assigning coefficient based on expert opinion	Per Coefficient	4
Raw Material Order	Placing the Order	Dimensioning the Order	Order Form	2

Planning department consists of two processes: CAD and CAM. CAD process consists of order acceptance and drawing sub-processes. Production of mold orders approved by the marketing department starts from the planning department. Definition, coding and general identification of the work is performed via order acceptance sub-process of the CAD process. This sub-process constant activity takes 5 hours in total: 3 hours for order acceptance, 2 hours for raw material order. Drawing sub-process involves drawing of the mold by Solidworks software. Factors affecting the activities here are whether the mold was utilized previously. It takes 8 hours if it is a new mold and a new project, and plus 4 hours if it has been produced before, however requires modification.

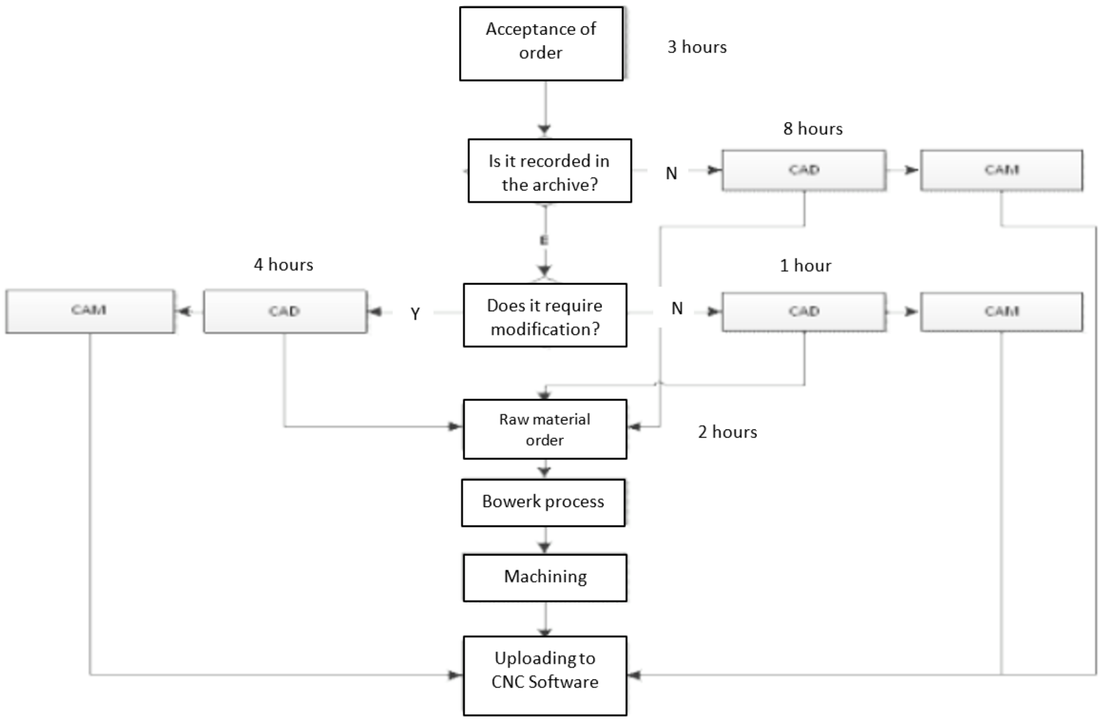

Figure 1: Planning Department Processes

We recommend using complexity coefficient in order to make it easier to measure the processes performed on the mold in terms of time. With this coefficient, a score between 1 and 5 indicates the difficulty level of the mold. This coefficient will be used for planning or other stages such as CNC and Assembly. After completion of the drawing stage, raw materials are order based on clarified dimensions. Time driver of CAD process is 4 hours per complexity coefficient, and placing the order takes 2 hours per mold.

CAD process time equation = 3 + (7x_1) + 1 + (4x_2) + (4x_3) + 2

x_1 = (1) for new mold, (0) if previously worked

x_2 = (1) a new mold requires modification,

x_3 = Complexity coefficient (coefficient between 1-5)

CAD time equation for an order with a new mold and complexity level 2; 3 + (7x1) + 1 + (4x0) + (4x2) + 2 = 21 hours

CAD time equation for an order with an old mold requiring modification and complexity level 1; 3 (7x0) + 1 + (4x1) + (4x1) + 2 = 12 hours.

During CAM process, activities similar to CAD process are performed. Orders with completed CAD processes are programmed for CNC machines in this process. Constant durations required for sub-processes differ. Constant activity of CAM process is 4 hours. New orders have an impact of 11 hours, modification takes 2 hours, and degree of complexity has an effect of 4 hours per coefficient.

CAM process time equation = $4 + (9x_1) + 2 + (4x_2) + (4x_3)$

x_1 = (1) for new mold, (0) if previously worked

x_2 = (1) a new mold requires modification,

x_3 = Complexity coefficient (coefficient between 1-5)

Time equation of CNC department

During CNC process, orders with completed CAM processes are processed on CNC machines. Constant durations and time drivers required for these processes differ based on planning stage. Constant activity of CNC process is 16 hours. These activities include sub-processes such as uploading CAM data to CNCs, preparation of CNC devices, attaching drill bits, connecting molds to CNC device. In CNC process, number of meshes and surface area size of the mold are of great impact. CNC process duration increases in parallel with number of meshes and surface area. Time drivers of the mold are 4 hours per mesh, 2 hours per surface area coefficient and 3 hours per complexity coefficient.

Time equation of CNC process = $16 + (4x_4) + (2x_5) + (3x_3)$

x_4 = Number of meshes of the mold

x_5 = Surface area of the mold

x_3 = Complexity coefficient (difficulty level 1-5)

Time equation of other machining processes department

The department called other machining processes includes the processes for Borwerk, Manual Lathe, Peck Drilling and Erosion. Borwerk processes can be performed within the enterprise or assigned to contractors outside the enterprise. Contracting is preferred for larger molds while small molds are produced within the enterprise. Constant activity of the process is 4 hours for Borwerk sub-process and 5 hours for other sub-processes. Area of the mold is effective in Borwerk process while the same process is applied to each mold in processes such as manual lathe and peck trilling. Area coefficient is considered as 2 hours for Borwerk process and 1 hour for other processes.

Time equation of Borwerk process = $(4x_6)$+$(2x_5)$

x_6 = (1) If Borwerk will be performed at the enterprise, (0) for contractor,

x_5 = Surface area of the mold (a coefficient between 1-3 based on size)

Time equation of other machining process = 5 + (x_5)

Time equation of assembly department

Assembly process is the process where the mold parts with completed CNC process are combined and the mold is constructed. It constitutes one of the most important parts of the process, and it is mainly carried out by manual labor. Constant activity of the process is 12 hours. Effect of each mesh of the mold is 4 hours, each complexity coefficient is 2 hours and application of hot runner technology is 3 hours.

Time equation of assembly process = 12 + $(4x_4)$ + $(2x_3)$ + $(2x_7)$

x_4 = Number of meshes on the mold,

x_3 = Complexity coefficient (a coefficient between 1-5)

x_7 = For hot runner technology, (1) if yes, (0) if no

Time equation of delivery department

Delivery process consists of test, painting and packing sub-processes. These processes are standard for each mold. In case of a problem during test process, the mold is interfered in Assembly department again. These sub-processes are 4 hours for each test, 4 hours for painting and 4 hours for packing. In this process, properties such as size of the mold and number of meshes are not of great importance.

Time equation of delivery process = $(4x_8)$ + $(4x_9)$ + 4

x_8 = Number of tests performed,

x_9 = For painting of the mold, (1) if yes, (0) if no

After time equations required for orders are created, durations requested by each sub-process of departments are calculated. Properties of 32 orders produced by the enterprise for January-March period are given below.

Table 6: Time Driver Properties of Orders

SN	Orders	Prod. Diam.	Prod. Form	No. Of Meshes	New	Old	Modif.	Compl. Coeff. (1-5)	Borwerk/ Contr.	Surface Area (1,2,3)	Hot Runner	No. Of Tests	Paint
1	Ø63 T 2 MESH	63	T	2	1	0	0	2	1	1	0	1	1
2	Ø63 ELBOW 90º 2 MESH	63	D90	2	1	0	0	2	1	1	0	1	1
3	Ø50 FORK 2 MESH	50	FORK	2	0	1	1	2	1	1	0	1	1
4	Ø100 FORK 1 MESH	100	FORK	1	0	1	1	2	0	3	0	2	1
5	Ø50 ELBOW-90º 2 MESH	50	D90	2	0	1	1	2	1	1	0	1	1
6	Ø63 ELBOW-45º 2 MESH	63	D45	2	0	1	1	2	1	1	0	1	1
7	Ø50 ELBOW-45º 2 MESH	50	D45	2	1	0	0	2	1	1	0	1	1
8	Ø100 T 1 MESH	100	T	1	1	0	0	2	0	3	0	2	0
9	Ø50 T 2 MESH	50	T	2	1	0	0	2	1	1	0	1	0
10	Ø40 ELBOW-90º 2 MESH	40	D90	2	0	1	1	2	1	1	1	1	1
11	Ø32 ELBOW-90º 4 MESH	32	D90	4	1	0	0	2	1	1	1	1	1
12	Ø32 ELBOW-45º 4 MESH	32	D45	4	1	0	0	2	1	1	1	1	1
13	Ø40 ELBOW-45º 2 MESH	40	D45	2	1	0	0	2	1	1	1	1	1
14	Ø32 T 4 MESH	32	T	4	1	0	0	2	1	1	0	1	1
15	Ø40 T 2 MESH	40	T	2	1	0	0	2	1	1	0	1	1
16	Ø75 CLAMP BODY	75	BODY	8	1	0	0	4	0	2	0	1	0
17	Ø75 CLAMP COVER	75	COVER	8	1	0	0	4	0	2	0	2	0
18	Ø75 T 1 MESH	75	T	1	0	1	1	2	0	2	0	1	1
19	A098-Ø75 ELBOW 90º 1 MESH	75	D90	1	0	1	1	2	0	2	0	1	1
20	Ø75 ELBOW 45º 1 MESH	75	D45	1	0	1	1	2	0	2	0	1	1
21	Ø90 T 1 MESH	90	T	1	1	0	0	2	0	3	0	1	1
22	Ø90 ELBOW-90º 1 MESH	90	D90	1	0	1	1	2	0	3	0	1	1
23	Ø90 ELBOW-45º 1 MESH	90	D45	1	0	1	1	2	0	3	0	1	1
24	Ø32 ELBOW-45º 8 MESH	32	D45	8	1	0	0	3	1	3	0	1	0
25	Ø40 ELBOW-45º 6 MESH	40	D45	6	1	0	0	3	1	3	0	1	0
26	Ø50 ELBOW-45º 4 MESH	50	D45	4	1	0	0	3	1	3	0	1	0
27	Ø63 ELBOW-45º 2 MESH	63	D45	2	0	1	0	3	1	3	0	1	0
28	Ø25 ELBOW-90º 132MESH	25	D90	32	1	0	0	4	1	3	0	2	1
29	Ø32 ELBOW-90º 16 MESH	32	D90	16	1	0	0	4	1	3	0	1	1
30	Ø40 ELBOW-90º 12 MESH	40	D90	12	1	0	0	4	1	3	0	1	1
31	Ø50 ELBOW-90º 8 MESH	50	D90	8	1	0	0	4	1	3	0	1	1
32	Ø63 ELBOW-90º 4 MESH	63	D90	4	1	0	0	4	1	3	0	1	1

Durations requested by orders are calculated below by using the time driver properties above.

Table 7: Calculation of Durations Requested by Orders (Hours)

SN	Planning		CNC	Other Machining		Assembly	Delivery			Total (hours)
	CAD	CAM		Borwerk	Manual		Test	Paint	Pack	
1	21	23	32	6	6	24	4	4	4	124
2	21	23	32	6	6	24	4	4	4	124
3	18	18	32	6	6	24	4	4	4	116
4	18	18	32	0	8	20	8	4	4	112
5	18	18	32	6	6	24	4	4	4	116
6	18	18	32	6	6	24	4	4	4	116
7	21	23	32	6	6	24	4	4	4	124
8	21	23	32	0	8	20	8	0	4	116
9	21	23	32	6	6	24	4	0	4	120
10	18	18	32	6	6	27	4	4	4	119
11	21	23	40	6	6	35	4	4	4	143
12	21	23	40	6	6	35	4	4	4	143
13	21	23	32	6	6	27	4	4	4	127
14	21	23	40	6	6	32	4	4	4	140
15	21	23	32	6	6	24	4	4	4	124
16	29	31	64	0	7	52	4	0	4	191
17	29	31	64	0	7	52	8	0	4	195
18	18	18	30	0	7	20	4	4	4	105
19	18	18	30	0	7	20	4	4	4	105
20	18	18	30	0	7	20	4	4	4	105
21	21	23	32	0	8	20	4	4	4	116
22	18	18	32	0	8	20	4	4	4	108
23	18	18	32	0	8	20	4	4	4	108
24	25	27	63	10	8	50	4	0	4	191
25	25	27	55	10	8	42	4	0	4	175
26	25	27	47	10	8	34	4	0	4	159
27	18	18	39	10	8	26	4	0	4	127
28	29	31	162	10	8	148	8	4	4	404
29	29	31	98	10	8	84	4	4	4	272
30	29	31	82	10	8	68	4	4	4	240
31	29	31	66	10	8	52	4	4	4	208
32	29	31	50	10	8	36	4	4	4	176
									Total	**4,849**

Durations of the orders stated above means the working hours required within the enterprise for each order. Contractor production durations were not added to the time calculation required for the order. Contractor processes were not included in the time equation but associated with orders in calculation of order costs as direct expense.

4.6. Calculation of order cost and determination of idle capacity

After order durations are calculated, the duration required for each resource group is multiplied by capacity cost rates. Idle capacity is calculated based on the practical capacity durations stated in Table 4 above.

Table 8: Comparison of Durations Requested from Orders and Practical Capacities

Orders	Planning Duration Request (hrs)	CNC Duration Request (hrs)	O. Machining Duration Request (hrs)	Assembly Duration Request (hrs)	Delivery Duration Request (hrs)	Total Duration Request (hrs)
Total Duration	1,456	1,480	393	1,152	368	4,849
Practical Capacity	1,764	1,764	44	1,323	441	5,733
Capacity Used	82.5%	83.9%	89.1%	87.1%	83.4%	84.6%
Idle Capacity	**17.5%**	**16.1%**	**10.9%**	**12.9%**	**16.6%**	**15.4%**

Table 8 shows the idle capacity calculations as a result of the durations requested from orders and practical capacity. According to this, it was respectively 17.5% for Planning department, 16.6% for Delivery department, 16.1% for CNC department, 12.9% for Assembly department and lastly 10.9 for Other Machining Processes department. Total average idle capacity rate is calculated as 15.4%.

Number of workers at the enterprise being 13 and the idle capacity rates ensure facing towards efficiency rather than reducing the number of personnel. In enterprises where number of employees are higher, these rates will provide more meaningful information about excessive personnel.

Following Table 9 shows the conversion costs assigned to orders.

Table 9: Conversion Costs Assigned to Orders

Orders	Planning Assigned Costs (34,26) TRY/h	CNC Assigned Costs (64,86) TRY/h	O. Machining Assigned Costs (127,76) TRY/h	Assembly Assigned Costs (57,80) TRY/h	Delivery Assigned Costs (73,30) TRY/h	Total Assigned Conversion Costs
1	1,508	2,075	1,533	1,387	880	7,383
2	1,508	2,075	1,533	1,387	880	7,383
3	1,233	2,075	1,533	1,387	880	7,108
4	1,233	2,075	1,02	1,156	1,173	6,659
5	1,233	2,075	1,533	1,387	880	7,108
6	1,233	2,075	1,533	1,387	880	7,108
7	1,508	2,075	1,533	1,387	880	7,383
8	1,508	2,075	1,022	1,156	880	6,641
9	1,508	2,075	1,533	1,387	586	7,087
10	1,233	2,075	1,533	1,560	880	7,281
11	1,508	2,594	1,533	2,023	880	8,538
12	1,508	2,594	1,533	2,023	880	8,538
13	1,508	2,075	1,533	1,560	880	7,556
14	1,508	2,59	1,533	1,849	880	8,364
15	1,508	2,075	1,533	1,387	880	7,383
16	2,056	4,151	894	3,005	586	10,692
17	2,056	4,151	894	3,005	880	10,986
18	1,233	1,946	894	1,156	880	6,109
19	1,233	1,946	894	1,156	880	6,109
20	1,233	1,946	894	1,156	880	6,109
21	1,508	2,075	1,022	1,156	880	6,641
22	1,233	2,075	1,022	1,156	880	6,366
23	1,233	2,075	1,022	1,156	880	6,366
24	1,782	4,086	2,300	2,890	586	11,644
25	1,782	3,567	2,300	2,427	586	10,662
26	1,782	3,048	2,300	1,965	586	9,681
27	1,233	2,529	2,300	1,503	586	8,151
28	2,056	10,507	2,300	8,554	1,173	24,590
29	2,056	6,356	2,300	4,855	880	116,447
30	2,056	5,318	2,300	3,930	880	14,484
31	2,056	4,281	2,300	3,005	880	12,522
32	2,056	3,243	2,300	2,081	880	10,560
Total Assigned Conversion Costs	49,889	95,982	50,209	66,579	26,982	289,641
Total Distributed Conversion Costs	60,439	114,409	56,343	76,464	32,324	339,980
Amount of Difference	10,550	18,427	6,134	9,885	5,342	50,339

Conversion costs transferred to orders were calculated by using time equations from each resource group. Total orders costs obtained if raw material costs are added to the conversion costs assigned to orders can be found in the Table 9 above. When

Table 9 is examined, it can be observed that there are significant differences between assigned costs and distributed costs. These differences indicate the idle capacity.

Table 10: Conversion Costs Assigned to Orders

Orders	Conversion Costs	Raw Material and Material Costs	TDABC Mold Costs	Volume-Based Mold Cost	Difference
1	7,383	6,400	13,783	16,500	2,717
2	7,383	6,030	13,413	15,500	2,087
3	7,108	6,980	14,088	18,000	3,912
4	6,659	6,980	13,639	18,000	4,361
5	7,108	6,400	13,508	16,500	2,992
6	7,108	6,400	13,508	16,500	2,992
7	7,383	5,820	13,203	15,000	1,797
8	6,641	6,210	12,851	16,000	3,149
9	7,087	6,400	13,489	16,500	3,011
10	7,281	6,400	13,681	16,500	2,819
11	8,538	5,430	13,967	14,000	32
12	8,538	6,980	15,518	18,000	2,482
13	7,556	6,600	14,156	17,000	2,844
14	8,364	6,210	14,574	16,000	1,426
15	7,383	6,980	14,363	18,000	3,637
16	10,692	7,950	18,642	20,500	1,858
17	10,986	6,600	17,586	17,000	-586
18	6,109	6,980	13,089	18,000	4,911
19	6,109	6,400	12,509	16,500	3,991
20	6,109	6,400	12,509	16,500	3,991
21	6,641	7,760	14,401	20,000	5,599
22	6,366	6,790	13,156	17,500	4,344
23	6,366	7,180	13,546	18,500	4,954
24	11,644	8,540	20,184	22,000	1,816
25	10,662	6,600	17,262	17,000	-262
26	9,681	5,820	15,501	15,000	-501
27	8,151	6,400	14,551	16,500	1,949
28	24,590	10,090	34,680	26,000	-8,680
29	116,447	6,980	23,427	18,000	-5,427
30	14,484	6,400	20,884	16,500	-4,384
31	12,522	6,400	18,922	16,500	-2,422
32	10,560	6,010	16,570	15,500	-1,070
Total Assigned Conversion Costs	289,641	215,520	505,161	555,500	50,339

In the Table 10 above, the raw material costs directly recorded by the application enterprise were added to conversion costs and TDABC mold costs were calculated. When cost calculated based on volume and costs calculated with TDABC methods were compared, it can be seen that there are cost differences between two methods although it differs for each order. For instance, cost of the order which is 13,783 TRY according to TDABC method in the first order was 16,500 TRY according to the volume-based costing method used by the enterprise. That means a 2,717 TRY difference between two costing methods. On the other hand, cost for order no. 28 was calculated as 34,680 TRY when it is 26,000 TRY according to the volume-based costing method used by the enterprise. In this instance, cost difference is -8,680 TRY. Based on these two examples, the enterprise calculates the cost of some orders higher or lower than they should be.

Total difference between both cost calculation methods is 50,339 TRY, and this is the idle capacity cost. This idle capacity cost is not included in order costs in TDABC method but considered as a management cost. If required, idle capacity cost can be estimated and distributed to order cost based on the TDABC costs above. In this case, cost differences between two methods for each order will be due to the difference of methods only.

5. Conclusion

Studies carried out in relation to TDABC are mainly focused on enterprises which carry out serial production and provide standard services. In this study, mold production industry which performs order-based production was examined. Mold production is a project-based activity and carries all properties of order-based production. With this study, TDABC method was applied to an enterprise conducting mold production, and it was seen that it is possible to apply the method to enterprises conducting order-based production.

Order costs in the application enterprise are calculated based on volume-based costing principle. Said order costs are not for control purposes, but rather calculated during proposal stage. Costing in enterprises is generally used as a marketing tool rather than a management tool. This condition is frequently observed in industries with high profitability rates. However, enterprises which do not accurately follow their costs may experience financial troubles in times when profitability decreases, and competition increases.

In the study, six-stage procedure of TDABC was used as it is generally accepted in the literature. Five resource groups as planning, CNC, other machining, assembly and delivery have been defined. Periodical costs of these groups were obtained from the accounting department. Daily working hours were taken as 7 hours as practical capacity. Costs assigned to resource groups were determined based on the time equations obtained from work analysis. Lastly, idle capacity was determined by calculating the order costs.

As a result of the capacity analysis of the enterprise of application, it can be seen that all production departments operate with a certain rate of idle capacity. The department with the highest idle capacity is planning department with 17.5% while other machining processes department has the lowest rate of 10.9%. Idle capacity rates require focusing on efficiency rather than reducing the number of personnel in small enterprises while they provide meaningful information on excess personnel in large-scale enterprises.

Application of TDABC is important especially in terms of determining the work processes, revealing the factors separating processes from each other and creating time equations. This process is a highly technical and difficult one which requires cooperation with workers. The fact that the enterprise has not made this kind of a definition may be interpreted as an additional contribution of the study to the enterprise. A part of the idle capacity calculated above is based on the deficient definition of the processes during production stage. This condition reveals that TDABC application is open to continuous development in enterprises which especially carry out order- and project- based production.

Volume-based costing method which is currently being used by the enterprise calculate the cost of most orders higher or lower than they should be. In the current competitive environment, this condition may cause losing the competitive advantage and decrease in the market share in the long run. On the other hand, resources cannot be effectively used in volume-based costing method since idle capacity is not calculated. TDABC provides a solution to this problem by calculating idle capacity based on resource groups. Order cost information calculated with TDABC method can be used as an effective management tool as well as for financial reporting purposes.

It can be interpreted as a restriction of the study considering the fact that sufficient support has not been obtained during collection of required data from workers despite the management finding the study beneficial and providing support. Although it was stated that the study will be used for academic purposes only, the workers were concerned that it was aimed at measuring their performances and therefore it would cause harm. Young workers were more eager to assist the study while older workers resisted or refused to help. Some workers left their jobs during the study and this caused challenges in terms of data collection.

Future studies may focus on enterprises from different industries which carry out order- and project- based production. When selecting the enterprises for application, factors such as application of a costing system, better defined work processes and higher number of personnel can be taken into consideration.

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