Time-Driven Activity-Based Costing in Logistics Sector: An Application on Recycling Business

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Abstract

The transformation instigated by the Industry 4.0 Revolution in production/service environments has diminished the reliability of volume-based allocation keys and brought forth the deficiencies of traditional cost methods. The necessity for managers to possess information enriched with more advanced cost methods has propelled the prominence of Time-Driven Activity-Based Costing (TD-ABC), which is also beneficial for monitoring logistics costs more accurately. This study aims to ascertain the logistics costs of a recycling business utilizing TD-ABC. The focus here is on the logistics sector, which is recognized for its challenging and complex nature in cost analysis. The constructed model demonstrates how decision-makers can develop cost calculation tools by considering the characteristics of their business processes, warehousing/transportation, supply chains, delivered products, and services. The costs derived from the TD-ABC method have been compared to those calculated using Activity Based Costing to delineate differences. The findings suggest that TD-ABC is more expository. A comparison of the methods implies that the logistics costs may be overstated compared to their predecessor, Activity-Based Costing (ABC).

Keywords: *Costing Methods, TD-ABC, Time Equations, Time Drivers, Logistics Costs*

Lojistik Sektöründe Zaman Etkenli Faaliyet Tabanlı Maliyetleme: Bir Geri Dönüşüm İşletmesinde Uygulama

Özet

Endüstri 4.0 Devrimi'nin üretim/hizmet ortamlarında tetiklediği dönüşüm, hacim bazlı dağıtım anahtarlarının güvenilirliğini azaltmış ve geleneksel maliyet yöntemlerinin eksikliklerini ortaya çıkarmıştır. Yöneticilerin daha gelişmiş maliyet yöntemleriyle zenginleştirilmiş bilgiye sahip olma zorunluluğu, lojistik maliyetlerinin daha doğru izlenmesine de fayda sağlayan Zaman Etkenli Faaliyet Tabanlı Maliyetleme'nin (ZE-FTM) ön plana çıkmasını sağlamıştır. Bu çalışma, ZE-FTM kullanan bir geri dönüşüm işletmesinin lojistik maliyetlerini tespit etmeyi amaçlamaktadır. Burada odak noktası, maliyet analizinin zorlu ve karmaşık doğasıyla tanınan lojistik sektörüdür. Oluşturulan model, karar vericilerin iş süreçleri, depolama/nakliye, tedarik zincirleri, teslim edilen ürün ve hizmetlerin özelliklerini dikkate alarak maliyet hesaplama araçlarını nasıl geliştirebileceklerini göstermektedir. ZE-FTM yönteminden elde edilen maliyetler, farklılıkları belirlemek için Faaliyet Tabanlı Maliyetleme kullanılarak hesaplanan maliyetlerle karşılaştırılmıştır. Bulgular ZE-FTM'nin daha açıklayıcı olduğunu göstermektedir. Yöntemlerin karşılaştırılması, lojistik maliyetlerin önceki yöntem olan FTM ile karşılaştırıldığında olduğundan fazla gösterilebileceğine işaret etmektedir.

Anahtar Kelimeler: *Maliyetleme Yöntemleri, ZE-FTM, Zaman Denklemleri, Zaman Sürücüleri, Lojistik Maliyetler*

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1. INTRODUCTION

Decision-makers need accurate information to identify cost-reduction opportunities that make logistics processes more efficient (Campanale et al., 2014). The rationality of decisions depends on accurately determining the cost of resources for a cost object. Once the actual profitability of cost objects is accurately determined, resources can be allocated to the most profitable investments in the supply chain.

The development of new production technologies has significantly altered the cost structures of businesses. Costs that cannot be directly allocated to a product or service have become more crucial than direct costs (Krajnc et al., 2012). Traditional costing methods have been proven inadequate in this context, providing problematic cost information that misguides decision-makers. Challenges emerging in cost analysis have led to the development of new approaches. One such approach is Activity Based Costing, which assumes that activities consume resources, thereby generating costs (Erdoğan, 2007).

The contemporary business environment, characterized by global economic integration, has increasingly compelled executives to consider logistics costs (Duran and Afonso, 2020). Various methods can be employed for logistics cost management, and Activity-Based Costing stands out as one of the most widely used approaches. ABC measures the costs consumed by activities required to obtain a cost object. Despite having several advantages over traditional methods, ABC exhibits certain shortcomings (Zamrud and Abu, 2020). Concerning logistics costs, it prompts executives to concentrate on each activity individually rather than the entire process. Consequently, the coordination of the logistics process may be overlooked. However, logistics costs display specific characteristics since they can emerge in various business functions (Škerlič and Sokolovskij, 2019). The efficiency of the logistics process depends on its integrity.

ABC requires time-consuming surveys and incurs high data processing costs. Organizational and behavioral barriers to accessing the necessary information for ABC complicate its implementation. Interviews with employees inherently harbor biases since employees tend to conceal inefficiencies in their activities. Therefore, cost drivers are calculated with the erroneous assumption that all resource capacities are fully utilized (Öker and Adıgüzel, 2010). Challenges encountered in data collection and the additional costs allocated, especially when combined with complex and variable production lines and customer diversity, further hinder its feasibility. The inadequacies of ABC and the implementation challenges encountered have led to the development of a much simpler, robust, and flexible cost model. This new version is known as Time-Driven Activity-Based Costing. This method is designed by Kaplan and Anderson (2003) as a model to conform to the complexity and variability of daily activities. It holds the potential to facilitate cost analyses further, even in complexity (Cidav et al., 2020). Therefore, TD-ABC emerges as a prominent alternative costing method for logistics companies. This new method is worth researching, especially in complex sectors such as logistics.

The research questions of this study are as follows:

- Is TD-ABC applicable for complex logistic activities?
- Does TD-ABC outperform ABC in determining logistic costs?

The study elaborates on determining logistic costs using TD-ABC and compares its performance with that of its predecessor in a recycling company. The following section of the study presents the theoretical framework and literature review. The subsequent section introduces the research methodology. In this section, cost calculations are provided based on the new method and its precursor, using data from the case study company. The subsequent section discusses the findings. The following section is the conclusion. The final section offers recommendations for future research.

2. THEORETICAL BACKGROUND AND LITERATURE

The next-generation production/service environments have increased the need for managers to have information enriched with more advanced cost methods. This demand has highlighted the prominence of TD-ABC, which is easily applicable in interlaced processes such as logistics. TD-ABC holds the potential to generate greater benefits in the service sector with complex activities (Kurt et al., 2019).

TD-ABC is cost-effective, easy to implement, and swift in application. It allows for associating cost drivers with the practical capacities of resources (Zhang and Yi, 2008). For TD-ABC, only two parameters must be calculated: (1) the unit cost of the utilized capacity and (2) the time required to execute a process or activity. When these two parameters are determined by experienced managers, cost drivers become much more rational. Consequently, the difference between practical capacity and ideal capacity is assessed, and workflows are developed accordingly. The distinctive features of TD-ABC can be listed as follows (Kaplan and Anderson, 2003):

- The unit cost of resources and practical time capacity can be calculated rapidly.
- Changes in business processes can be easily updated to reflect order variety and resource costs.
- The required data can be collected from information systems easily.
- Calculations can be verified by observing production processes and employees.
- Customer behaviors and order variations can be added to the model without increasing its complexity.

In TD-ABC, time is the primary cost driver, associating cost objects with activities. Costs are allocated from resource cost pools to cost objects through time drivers. This method simplifies the process by eliminating the need for extensive employee interviews. It enables managers to predict the time required for activities more easily. TD-ABC adapts more swiftly to the complexities of activities. Changes in the utilization of resources are added to the model through time equations (Kaplan and Anderson, 2007; Namazi, 2016; Schuhmacher and Burkert, 2014; Siguenza-Guzman et al., 2013).

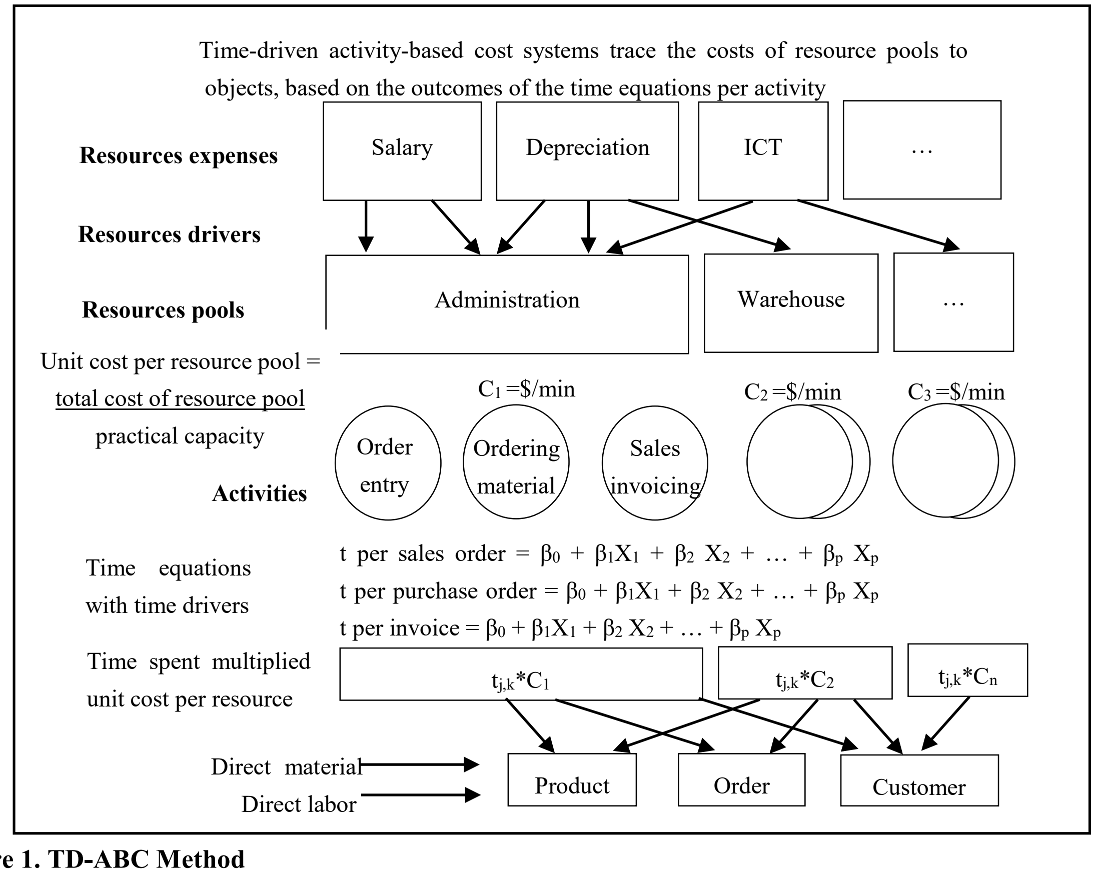

Figure 1. TD-ABC Method
Source: Everaert et al. (2008)

A formulation consisting of multiple time equations facilitates calculating cost models for complex logistics activities (Bruggeman et al., 2005; Everaert et al, 2009). Equations modeling all possible subtasks will be able to capture the diversity in logistics and distribution activities (Everaert et al., 2008). Data required for time equations can be obtained from the business information system. However, measurements in the field have been found to enhance the precision of time estimations. Additionally, a greater amount of data enables a better identification of cost behaviors (Varila, 2007). Predicting time, especially in non-routine activities, is more challenging. Formal methods should be developed to monitor time (Somapa, 2010).

When expressed as a function of different features in equations, the consumed time is defined as time drivers. Time drivers are characteristics that determine the time spent on a specific activity. Equations model how these drivers guide the time spent. Several drivers can be identified in complex environments where multiple factors affect the time required for an activity (Everaert et al., 2009). When formulating equations, the beginning and end of the process should be well-defined. It is convenient to begin with the most time-consuming process (Kaplan and Anderson, 2007; Köse, 2010).

TD-ABC relies on two main calculations. The total resource cost is divided by the practical capacity to calculate the cost per unit of time. Subsequently, the unit cost is allocated to the cost object by multiplying it by the time required for the activity. The other stages are essentially executed for these two calculations (Everaert et al., 2008). The model is presented in Figure 1. Considering the formulas provided in the figure, the cost of a cost object is formulated as follows:

$$\sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{l} t_{j.k}\, c_I \qquad (1)$$

In Equation 1, n represents the number of resource cost pools, m represents the number of activities, and l symbolizes the occurrence count of activity j.

Time equations are mathematical expressions of the duration required for activities as a function of various time drivers (Hoozée and Bruggeman, 2010). They reflect the assumption that the duration of an activity is not constant and can vary depending on the conditions in the execution of the activity. For instance, the duration may vary based on the mode of transportation used for a transport activity. The total time required for an activity is calculated with the Equation 2:

$$t_{j,k} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_i X_i + \ldots + \beta_p X_p \qquad (2)$$

Time equations can incorporate continuous, discrete, or dichotomous variables. Continuous variables are those like the weights of pallets, water temperature, or distance in kilometers. Discrete variables are integer values, such as the number of orders. On the other hand, dichotomous variables take only the values 0 and 1 depending on whether an activity occurs or not. For instance, they can take values of 0 or 1 based on whether a customer is new or old, an order is regular or urgent, or an activity is conducted during the day or night shift. Incorporating these into the model simplifies the equations (Somapa et al., 2011).

3. METHODOLOGY

This study tests the convenience and the advantages of the TD-ABC method. The application is conveyed in a small-scale recycling/refurbishing company operating in Turkey with logistics as its core activity. The study distinguishes itself from other studies in the literature in this respect, potentially contributing to the existing body of knowledge. The costs are distinctively derived using the ABC and TD-ABC methods, and the differences are presented comparatively.

The methodological approach used is a case study, a common construct in cost accounting studies (Burritt et al., 2019). Investigating a single case in detail is more effective in gaining as much meaningful information about the real situation as possible (Hancock, Algozzine and Lim, 2021). By elaborating a case study, the applicability of TD-ABC on complex and dynamic logistics activities could be thoroughly demonstrated.

The data of our study is obtained from the 3rd quarter cost accounting records for 2022 of the Eskisehir Branch of the company based in Bursa, Turkey. According to agreements with 28 municipalities from various regions of Turkey, the company places containers in different locations of cities. It contributes to the economy by refurbishing used garments (i.e., clothing and shoes).

3.1. Company's Activity and Cost Data

The branch has 22 workers, one branch manager, and one secretary. Interviews were conducted with the managers to determine the activities[2]. In the branch, collection, inspection/separation, repair, washing/drying, packaging, storage, distribution, and disposal activities are carried out. There are 307 containers, 133 in the Odunpazarı Region and 174 in the Tepebası Region. The company's activities are summarized in Table 1.

Table 1. Activity Definitions

Activity	Definitions
Collection	– The containers are periodically inspected at regular intervals. – Garments are transported to the facility using a vehicle suitable for the type of container.
Inspection/Separation	– The garments are assessed on whether they are reusable or not. – Usable garments are categorized into six classes based on gender (female, male, child) and type (clothing, shoes).
Repair	– The parts that need repair or missing parts for garments requiring repair are identified. – Garments undergo the necessary repair processes such as stitching, gluing, and painting.
Washing/Drying	– Garments that have undergone the repair process or are directly usable are laundered. – Laundered garments are dried in industrial machines.
Packaging	– Garments are ironed and folded. – Garments are packed according to their sizes.
Storage	– Received garments are placed on the shelves according to the classification. – Inventory records indicating the quantity and type of garments placed on the shelves are created.
Distribution	– Garments suitable for the requests from municipalities are loaded onto vehicles. – Prepared garments for use are delivered to municipal units.
Disposal	– The useful parts of garments that cannot be made usable are separated and delivered to the repair section. – Unrecyclable garments are either disposed of or, if suitable, acquired by another textile manufacturing company.

Since the company's field of activity is recycling, there is no direct material cost. Direct labor consists of wages paid to workers directly involved in recycling activities. Direct labor is defined as wages paid to workers, excluding non-production-related deductions. After deductions during the case period, the total direct labor cost allocated for 22 workers is 363,023.1₺ (22 x 5,500.35₺ x 3).

In the sample company, indirect materials, indirect labor, energy, communication, rent, fuel, and expenses for the repair/maintenance of vehicles and machinery and amortization constitute the overhead costs. Indirect materials mainly include machine oils, detergents, and cleaning supplies. Conversely, indirect labor consists of components other than direct labor, including seniority premiums, insurance premiums, leave allowances, bonuses, and the gross salaries of the branch manager and secretary. Additionally, expenses related to external benefits and services, such as electricity, water, heating, meals, fuel, communication, repairs, and maintenance, are encompassed within the scope of overhead costs. The overhead costs and resource drivers are presented in Table 2.

[2] In many cases, managers may refrain from sharing certain data, even if it is for research purposes. In such situations, the missing data required for our research has been supplemented in a manner likely to be representative of an equivalent business.

Table 2. Overhead Costs and Resource Drivers

Cost Elements	October	November	December	Total	Resource Drivers
Indirect material	10,545.00	11,715.00	12,050.00	34,310.00	Direct
Indirect labor	117,620.00	117,620.00	117,620.00	352,860.00	Num. of employees
Repair/Maintenance	1,960.00	1,054.00	1,032.00	4,046.00	Machine hour
Inspection-Ins.-Main.	1,150.00	1,150.00	1,150.00	3,450.00	Km
Fuel for delivery vehicles	7,700.00	8,600.00	8,350,00	24,650.00	Km
Meals	37,400.00	37,400.00	37,400.00	112,200.00	Num. of employees
Heating	1,200.00	4,300.00	7,600.00	13,100.00	m2
Electricity	4,521.00	3,421.00	4,326.00	12,268.00	Kw
Water	342.00	432.00	365.00	1,139.00	m3
Depreciations	15,283.34	15,283.34	15,283.34	45,850.03	Direct
Telephone / Internet	425.00	425.00	425.00	1,275.00	Num. of phones
Rent of the facility	14,500.00	14,500.00	14,500.00	43,500.00	m2
TOTAL	**212,646.34**	**215,900.34**	**220,101.34**	**648,648.03**	

3.2. Calculation of Costs with ABC

The first stage makes use of resource drivers, also known as cost drivers, to ascertain the portion of activities that go toward overhead costs or, to put it another way, to aggregate costs in activity cost pools. However, some may not require any resource drivers because certain costs can be directly associated with activities or easily determined for which activity and how much cost is allocated. For instance, the depreciation amounts for machinery should be included in the cost of the activity in which the machine is used. Resource drivers were identified through discussions with employees and observations. At this stage, it is crucial to ascertain how much an activity benefits from a particular resource. Table 3 illustrates the resource drivers consumed by activities.

Table 3. Resource Drivers Consumed by Activities

Resource Drivers	Collect	Insp. Sep.	Repair	Wash. Dry.	Package	Storage	Distr.	Disposal	Total
Num. of employees	4	3	2	5	4	2	1	1	22
Machine hour	-	480	630	1,725	-	-	-	-	1111,725
Km	14	-	-	-	-	-	4,25	-	18,25
m2	-	60	45	85	50	140	-	-	380
Kw	-	1,65	1,8	15,4	600	300	-	540	1458,85
m3	-	18	22	145	6	-	-	5	196
Num. of phones	2	-	-	-	-	1	1	-	4

The total overhead costs not directly associated with activities is divided by the total resource driver consumed for activities to calculate the unit cost. Subsequently, the cost of each activity is calculated by multiplying the resource driver consumed for each activity. For example, the total electricity expenditure during the case period is divided by the total electricity consumption in terms of the resource driver (Kilowatt), yielding the unit cost. The cost of an activity is then determined by multiplying the unit cost by the resource driver.

12,268₺ / 20,290kw = 0.604₺/kw (unit cost)

Inspection/Separation= 1,650 x 0.604= 997.64₺; Repair= 1800 x 0.604= 1,088.34₺; Washing/Drying= 15,400 x 0.604= 9,311.35₺; Packaging = 600 x 0.604= 362.78₺; Storage= 300 x 0.604 = 181.39₺; Disposal= 540 x 0.604= 326.50₺

Costs that can be directly associated with activities are added directly to the activity cost pool. For example, amortizations are directly added to the cost of the relevant activity. The calculated amortization amounts for vehicles, machinery, and fixed assets for the case period are specifically linked to the corresponding activity. The allocated amortization amount for vehicles, machinery, and fixed assets (useful life of assets 5 years) is as follows:

Sewing Machine (Unit Cost: 28,000, 2 Units) = 28,000 / 5 (years) / 12 (months) x 3 (number of periods) x 2 (number of machines) = 2800₺; Industrial Washing Machine (Unit Cost: 18,000, 3 Units) = 18,000 / 5 (years) / 12 (months) x 3 (number of periods) x 3 (number of machines) = 2700₺; Industrial Drying Machine (Unit Cost: 37,002, 1 Unit) = 37,002 / 5 (years) / 12 (months) x 3 (number of periods) = 1,850.01₺; Industrial Oven (Unit Cost: 180,000, 1 Unit) = 180,000 / 5 (years) / 12 (months) x 3 (number of periods) = 9,000₺; Panel Van Vehicle (Unit Cost: 250,000.02₺, 2 Units) = 250,000.02 / 5 (years) / 12 (months) x 3 (number of periods) x 2 (number of vehicles) = 25,000.02₺; Computer (Unit Cost: 30,000₺, 1 Unit) = 30,000 / 5 (years) / 12 (months) x 3 (number of periods) = 1,500₺; Forklift (Unit Cost: 60,000₺, 1 Unit) = 60,000 / 5 (years) / 12 (months) x 3 (number of periods) = 3,000₺

Table 4. Allocation of Costs to Activities

Activity \ Cost	Indirect material	Indirect Labor	Repair / Mainten.	Inspection-Insurance-Mainten.	Fuel for delivery vehicles	Meals	Heating
Collection	-	64,156.36	-	2,646.58	18,909.59	20,400.00	-
Ins. / Separation	6,600.00	48,117.27	685.04	-	-	15,300.00	2,068.42
Repair	7,400.00	32,078.18	899.11	-	-	10,200.00	1,551.32
Washing / Drying	4,450.00	80,195.45	2,461.85	-	-	25,500.00	2,930.26
Packaging	7,475.00	64,156.36	-	-	-	20,400.00	1,723.68
Storage	3,450.00	32,078.18	-	-	-	10,200.00	4,826.32
Distribution	-	16,039.09	-	803.42	5,740.41	5,100.00	-
Disposal	4,935.00	16,039.09	-	-	-	5,100.00	-
Total	**34,310.00**	**352,860.00**	**4,046.00**	**3,450.00**	**24,650.00**	**112,200.00**	**13,100.00**

Activity \ Cost	Electricity	Water	Amortization	Telephone / Internet	Rent of the facility	TOTAL
Collection	-	-	1,250.01	637.50	-	119,250.04
Ins. / Separation	997.64	104.60	-	-	6,868.42	80,741.40
Repair	1,088.34	127.85	2,800.00	-	5,151.32	61,296.11
Washing / Drying	9,311.35	842.63	4,550.01	-	9,730.26	139,971.82
Packaging	362.78	34.87	-	-	5,723.68	99,876.38
Storage	181.39	-	4,500.00	318.75	16,026.32	71,580.95
Distribution	-	-	12,500.01	318.75	-	40,501.69
Disposal	326.50	29.06	9,000.00	-	-	35,429.65
Total	**12,268.00**	**1,139.00**	**45,850.03**	**1,275.00**	**43,500.00**	**648,648.03**

Amortization amounts should be included in the cost of activities that utilize the fixed assets. Accordingly, sewing machines are associated with repair, washing and drying machines with washing/drying, and the oven with disposal. Since vehicles are used for both collection and distribution activities, half of the amount is allocated to the collection and the other half to the distribution activity cost pool, while the calculated amounts for the computer and forklift are allocated to the storage activity cost pool. After these calculations, the share of costs allocated by activities is determined. The overhead costs[3] allocated to activities are presented in Table 4.

After determining the total costs of activities, the next is to allocate them to cost objects such as products, services, customers, customer groups, or distribution channels. For this aim, activity drivers must be identified. Activity drivers represent the relationship between activities and cost objects. The drivers must be convenient and reflect the correlation between activities and objects. Interviews, observations, and rational assessments may help to obtain such drivers. It has been identified that the sample company has eight activities. The costs of these have been allocated to the garments delivered to municipal units during the case-study period. In this period, deliveries

[3] In order to avoid inflating the volume of the study, a detailed presentation of calculations has been omitted. The calculations for each activity follow a similar methodology.

were made to two entities of Tepebası Municipality and one of Odunpazarı Municipality. Activity drivers are presented in Table 5.

Table 5. Activity Drivers

Activity	Activity Drivers	Tepebaşı 1	Tepebaşı 2	Odunpazarı	Total
Collection	Number of Routes	36	21	33	90
Inspection/Separation	Number of Days	25	18	21	64
Repair	Labor Hours	210	180	252	642
Washing/Drying	Machine Hours	495	472	512	1479
Packaging	Labor Hours	280	196	332	808
Storage	Number of Packages	144	78	105	327
Distribution	Number of Routes	24	16	32	72
Disposal	Kilograms	390	498	426	1314

The amount collected in the activity cost pool is divided by the total quantity of the activity driver to calculate overhead rates. Then, multiplying this rate by the usage quantity determines the cost object's share from that activity cost pool. For example, in the storage activity cost pool, the collected amount of 71,580.95₺ is divided by the quantity of the activity driver to find the overhead rate. Subsequently, the share is determined by multiplying it by the quantity of usage for each delivery.

Activity Cost Pool Overhead Rate = 71,580.95₺ / 327 Package= 218.90₺/Package

Tepebası 1= 218.90 x 144 = 31,521.89₺

Tepebası 2= 218.90 x 78 = 17,074.36₺

Odunpazarı= 218.90 x 105 = 22,984.71₺

A similar loading process is carried out for each activity cost pool. Other calculations are not presented for brevity. Table 6 shows the shares of cost objects from activity cost pools.

Table 6. Costs of Objects (ABC)

Activity	Tepebaşı 1	Tepebaşı 2	Odunpazarı	Total
Collection	47,700.02	27,825.01	43,725.01	119,250.04
Inspection/Separation	31,539.61	22,708.52	26,493.27	80,741.40
Repair	20,050.14	17,185.83	24,060.16	61,296.13
Washing/Drying	46,846.55	44,669.84	48,455.42	139,971.82
Packaging	34,610.63	24,227.44	41,038.31	99,876.38
Storage	31,521.89	17,074.36	22,984.71	71,580.95
Distribution	13,500.56	9,000.37	18,000.75	40,501.69
Disposal	10,515.65	13,427.68	11,486.32	35,429.65
Total	**236,285.04**	**176,119.04**	**236,243.97**	**648,648.03**

3.3. Calculation of Costs With TD-ABC

TD-ABC initializes with the identification of activities. The process of identifying the activities is similar to that in ABC, and no separate classification has been deemed necessary. The costs for the resource groups are also determined as in ABC. The third stage is determining the practical time capacity of the resource group. The most significant threat at this stage is the Hawthorne Effect, which arises in the time studies. According to this, if the observer is present in the same environment as the workers and the workers are aware of it, they tend to exhibit higher performance than usual (Mayo, 1930). In fact, the data that serve as inputs for cost methods should be collected from the production site. During this process, data regarding the time taken to complete an activity should be gathered without the employees being aware of it[4].

TD-ABC bases cost drivers on practical capacity. For the case period, three-month (92 days) practical capacities of the resource cost pools must be determined. For this purpose, first, theoretical capacity is estimated. In the sample company, 9 hours of work is performed each day, with activities pausing for 1 hour for tea and lunch breaks. For instance, 4 employees worked 8 hours a day for a total of 66 days in the collection activity. Therefore, the theoretical capacity is calculated as 126,720 minutes. If the practical capacity is considered as 85% of the theoretical capacity, it is found to be 107,712 (126,720 x 0.85) minutes. Then, to calculate the unit capacity cost rate of the total resource cost pool, the total cost of 119,250.04₺ is divided by the practical capacity. The same calculations were performed for each resource cost pool, and the results are presented in Table 7.

Table 7. Utilizations of Activities' Capacities

Activity	Number of Employees	Daily Working Hours	Total Working Days	Resource Cost (₺)	Theoretical Capacity (min)	Practical Capacity (min)	Capacity Cost Rate (₺/min)
Collection	4	8	66	119,250.04	126,720	107,712	1.11
Inspection/Separation	3	8	64	80,741.40	92,160	78,336	1.03
Repair	2	8,5	68	61,296.13	69,360	58,956	1.04
Washing/Drying	5	8,5	66	139,971.82	168,300	143,055	0.98
Packaging	4	8	65	99,876.38	124,800	106,080	0.94
Storage	2	7	69	71,580.95	57,960	49,266	1.45
Distribution	1	7,5	68	40,501.69	30,600	26,010	1.56
Disposal	1	7,5	67	35,429.65	30,150	25,627.5	1.38

Once the capacity cost rates are calculated, the costs allocated to activities are determined. For this purpose, time equations for activities and, if necessary, sub-activities should be formulated. The equations allow for estimating how much time is needed to execute an activity. TD-ABC argues that the costing should be based on time. Parallel to this, the following time equation has been formulated for the collection activity.

$$t_{j.k} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_i X_i + \ldots + \beta_p X_p \quad (3)$$

Where β0 represents the fixed time required for the activity, and X represents the time drivers. For example, the duration of the collection activity can vary depending on whether it is carried out from the Odunpazarı or Tepebası region or which routes are used. It can also vary based on the type of vehicle or the delivered product. Equations should be created that reflect all variations depending on the characteristics of the activity. The variables in the time equation for the collection activity are explained below:

Collection Activity Route Time = 6 hours + 1 hour (If it's in the Odunpazarı region) + 0.5 hours (If it's the O2 route) + 0.5 hours (If it's the T3 route) + 0.5 hours (If a large container vehicle is needed) + 0.2 hours (If it's a shoe container)

$$t_{j,k} = 6 \text{ hours} + 1 \text{ hour } X_1 + 0{,}5 \text{ hour } X_1 + 0{,}5 \text{ hour } X_3 + 0{,}5 \text{ hour } X_4 + 0{,}2 \text{ hour } X_5 \quad (4)$$

The time required for each activity is determined by specified equations as such. In this stage, the total time for an activity is calculated by multiplying the time determined per activity unit by the number of units. For example, 45 rounds were organized for collection, and 4 workers spent an average of 4.5 hours per round. The number of rounds is determined as the activity unit for the collection activity. The time required for this activity is calculated as 4 × 4.5 × 90 × 60 = 97,200 minutes. This time is distributed to delivery centers based on the utilization rate of the activity. The required times for activities are presented in Table 8.

[4] This stage relies on interviews with employees and fictional assessments for data that cannot be obtained. Observations that workers are not aware of have not been possible due to concerns among managers that it may cause disruptions in activities. This limitation is a significant constraint in our study.

Table 8. Time Consumed by Cost Objects

Activity	Delivery Centers	Activity Unit	Number of Activities	Total Duration (minutes)
Collection	Tepebası 1	Number of Routes[5]	36	38,880
	Tepebası 2		21	22,680
	Odunpazarı		33	35,640
Inspection/Separation	Tepebası 1	Number of Days	21	30,240
	Tepebası 2		13	18,720
	Odunpazarı		18	25,920
Repair	Tepebası 1	Labor Hours	315	18,900
	Tepebası 2		270	16,200
	Odunpazarı		378	22,680
Washing/Drying	Tepebası 1	Machine Hours	787	47,220
	Tepebası 2		742	44,520
	Odunpazarı		810	48,600
Packaging	Tepebası 1	Labor Hours	560	33,600
	Tepebası 2		392	23,520
	Odunpazarı		664	39,840
Storage	Tepebası 1	Number of Packages[6]	144	17,280
	Tepebası 2		78	9,360
	Odunpazarı		105	12,600
Distribution	Tepebası 1	Number of Routes	13	6,240
	Tepebası 2		9	4,320
	Odunpazarı		16	7,680
Disposal	Tepebası 1	Kilograms[7]	213	6,390
	Tepebası 2		242	7,260
	Odunpazarı		186	5,580

In the final stage, the estimated time required for cost objects is multiplied by the capacity cost rate for each activity. This determines the share of product deliveries from activities. For example, the share of Tepebası 1 unit from the collection activity is calculated as 1,1071₺/min x 38880 min = 43,044.80₺. The costs are presented in Table 9.

Table 9. Costs of Objects (TD-ABC)

Activity	Tepebası 1	Tepebası 2	Odunpazarı	Total
Collection	43,044.80	25,109.47	39,457.73	107,612.00
Inspection/Separation	31,168.55	19,294.82	26,715.90	77,179.28
Repair	19,650.19	16,843.02	23,580.23	60,073.45
Washing/Drying	46,202.29	43,560.49	47,552.55	137,315.33
Packaging	31,635.05	22,144.54	37,510.13	91,289.72
Storage	25,106.95	13,599.60	18,307.15	57,013.69
Distribution	9,716.67	6,726.92	11,958.98	28,402.57
Disposal	8,834.08	10,036.85	7,714.27	26,585.20
Total	**215,358.59**	**157,315.70**	**212,796.95**	**585,471.24**

4. DISCUSSION

In the study, the logistics costs of a recycling company were calculated using the ABC and TD-ABC. Differences between the two methods were identified. Costs in the ABC were calculated higher than those in the TD-ABC. The calculations were shown to be straightforward for TD-ABC, since time is used as the only driver. The

[5] An average of 4.5 hours is required for one route.
[6] It takes 2 hours to store one package.
[7] The disposal of one kilogram of product requires 0.5 hours.

outcomes of the latter are deemed more realistic with the utilization of practical capacity. The calculated costs and identified differences are presented in Table 10.

Table 10. Differences in Costs of the Cost Objects (ABC, TD-ABC)

Delivery Centers	ABC	TD-ABC	Difference	(%)
Tepebası 1	236,285.03	215,358.59	20,926.44	9.71%
Tepebası 2	176,119.04	157,315.70	18,803.34	11.95%
Odunpazarı	236,243.96	212,796.95	23,447.01	11.02%
Total	**648,648.03**	**585,471.24**	**63,176.79**	**10.79%**

For the quarter-year, an overhead cost of 648,648.03₺ is allocated according to the ABC. This cost is calculated as 585,471.24₺ for the TD-ABC. In the sample company, an idle capacity cost of 20,926.44₺ is attributed to deliveries to Tepebaşı-1, 18,803.34₺ to Tepebası 2, and 23,447.01₺ to deliveries to Odunpazarı. The highest difference rate is reached in the calculations for Tepebası 2. This could be interpreted as an indication of a less successful correlation between cost drivers and cost objects for Tepebası 2 compared to other units.

The processing of orders, inventory management, demand forecasting, transportation, storage, packaging, transportation, and location selection are defined as fundamental logistics activities (Bowersox, Closs, Cooper and Bowersox, 2020). The sample company's collection, packaging, storage, and distribution processes are classified as such. Differences between the two methods in terms of logistics activities are summarized in Table 11. The highest discrepancy is observed in the distribution activity. The main argument for this difference is that subjective cost drivers in ABC cannot accurately determine the cost associated with the distribution activity. In contrast, in TD-ABC, the costs based on a single driver of time could be consistently allocated. Krajnc et al. (2012) calculated the logistics costs of a manufacturing company in ABC 106% higher than the traditional method. In our study, however, the logistics costs of the sample company are calculated to be an average of 16% lower in TD-ABC than in ABC. When these findings are combined, the logistic costs can be overstated depending on the technique used to assess the costs better than the traditional methods. TD-ABC, a contemporaneous method in the field, offers more moderate logistic costs than ABC. This is also valid for various types of activities reported in our study.

Table 11. Costs of Fundamental Logistics Activities

	Total		**Difference**	
Activity	**ABC**	**TD-ABC**	**Amount**	**(%)**
Collection	119,250.04	107,612.00	11,638.04	11%
Packaging	99,876.38	91,289.72	8,586.66	9%
Storage	71,580.95	57,013.69	14,567.26	26%
Distribution	40,501.69	28,402.57	12,099.12	43%
Total	**331,209.06**	**284,317.98**	**46,891.08**	**16%**

The results are consistent with theoretical research (Kaplan and Anderson, 2003; Kaplan and Anderson, 2007; Namazi, 2016; Hoozée and Bruggeman, 2010) suggesting that the TD-ABC provides more accurate cost calculations by considering practical capacity. Furthermore, similar results have been reported in research conducted on companies from diverse sectors (Campanale et al., 2014; Zamrud and Abu, 2020; Öker and Adıgüzel, 2010; Kurt et al., 2019; Akhavan et al., 2016), and in case studies specifically focusing on logistics costs (Krajnc et al., 2012; Bruggeman et al., 2005; Everaert et al., 2009; Everaert et al., 2008; Varila, 2007; Somapa et al., 2011). Nevertheless, the results may vary depending on the company size or industry, which hinders the generalization of the findings. Moreover, utilizing alternative cost drivers in the ABC could change the discrepancies between the two methods.

Accounting for indirect costs based on time drivers, rather than cost drivers with inherent biases, ensures a more consistent allocation. This can significantly affect managerial decisions. Cost allocation considering practical capacity becomes especially crucial in companies engaged in large-scale production with substantial differences in capacity, particularly those operating across multiple stages. However, verifying this claim lies beyond the scope of our research. The implementation of the TD-ABC demonstrated in this study contributes to the applied sciences literature on logistics costs. Furthermore, the foundations provided in this study establish the relationship between logistics costs and financial reporting and offer beneficial constructs to the accounting information system in companies alike.

5. CONCLUSION

The transformation brought about in manufacturing environments by the Industry 4.0 revolution has invalidated the allocation keys such as labor or machine hours. Volume-based allocation keys can no longer reflect the relationship between costs and products or services, nor can they explain cost changes. This has exposed the shortcomings of traditional cost methods. The evolving circumstances have mandated adopting a modern method, i.e., the TD-ABC approach.

The development of TD-ABC can be justified by three key reasons: (1) Establishing and updating the costing model in ABC is challenging. (2) ABC fails to respond to changes in the manufacturing. (3) The selection of cost drivers in ABC can be subjective and prone to errors due to its relative nature. TD-ABC addresses the shortcomings of ABC and facilitates ease of implementation by expressing activities with a single driver. This allows for a time-based comparison of the cost of each activity with another. Furthermore, proposing a model that considers practical capacity is a significant advantage of TD-ABC over its predecessors. Calculations based on the data of the sample company reflect this aspect.

6. FURTHER RESEARCH

Examining the cost data and characteristics of the sample company reveals that multi-criteria decision-making methods such as AHP (Analytic Hierarchy Process), ANP (Analytic Network Process), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), and linear programming can be used to determine collection routes and identify the most rational locations for garment containers. In the sample company, there is a potential for TD-ABC to reduce costs when used in conjunction with these methods. Future studies testing TD-ABC on the cost accounting data of a larger logistics company, particularly in combination with customer profitability analysis or analysis methods such as cost-volume-profit, and multi-criteria decision-making methods, will provide significant contributions to the literature.

In TD-ABC, time equations are employed to determine the duration of an activity. However, the time spent on a sub-activity or process can be more easily and accurately identified through advanced technologies. The Internet of Things, automation, digital image processing techniques for object recognition, and advanced technologies such as Radio Frequency Identification (RFID) and Global Positioning System (GPS) have the potential to provide near-precise results for time equations. On the other hand, new technologies may also eliminate the need for cost allocation. Future studies examining the logistics costs of a company utilizing advanced technologies through TD-ABC, or investigating whether the logistics costs can be determined without any cost allocation method, can offer valuable insights into the literature.

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REFERENCES

Akhavan, S., Ward, L., and Bozic, K. J. (2016). Time-driven activity-based costing more accurately reflects costs in arthroplasty surgery. *Clinical Orthopaedics and Related Research*, *474*(1), 8-15. doi: 10.1007/s11999-015-4214-0

Bowersox, D. J., Closs, D. J., Cooper, M. B., and Bowersox, J. C. (2020). *Supply chain logistics management*. Mcgraw-hill.

Bruggeman, W., Everaert, P., Anderson, S. R., and Levant, Y. (2005). Modeling logistics costs using Time-Driven ABC: a case in a distribution company. *Conceptual Paper and Case Study*, 1-51.

Burritt, R. L., Herzig, C., Schaltegger, S., and Viere, T. (2019). Diffusion of environmental management accounting for cleaner production: Evidence from some case studies. *Journal of Cleaner Production*, 224, 479-491. doi: 10.1016/j.jclepro.2019.03.227

Campanale, C., Cinquini, L., and Tenucci, A. (2014). Time-driven activity-based costing to improve transparency and decision making in healthcare: a case study. *Qualitative Research in Accounting & Management*, *11*(2), 165-186. doi: 10.1108/QRAM-04-2014-0036

Cidav, Z., Mandell, D., Pyne, J., Beidas, R., Curran, G., and Marcus, S. (2020). A pragmatic method for costing implementation strategies using time-driven activity-based costing. *Implementation Science*, 15, 1-15. doi: 10.1186/s13012-020-00993-1

Duran, O., and Afonso, P. S. L. P. (2020). An activity-based costing decision model for life cycle economic assessment in spare parts logistic management. *International Journal of Production Economics*, 222, 107499. doi: 10.1016/j.ijpe.2019.09.020

Erdoğan, N. (2007). *Logistics Costing and Activity Based Costing*. Anadolu University Press, Number: 1748.

Everaert, P., Bruggeman, W., and De Creus, G. (2009). Sanac Inc.: From ABC to time-driven ABC (TDABC)– An instructional case. *Journal of accounting education*, 26(3), 118-154. doi: 10.1016/j.jaccedu.2008.03.001

Everaert, P., Bruggeman, W., Sarens, G., Anderson, S. R., and Levant, Y. (2008). Cost modeling in logistics using time-driven ABC: Experiences from a wholesaler. International Journal of Physical *Distribution & Logistics Management*, *38*(3), 172-191. doi: 10.1108/09600030810866977

Hancock, D. R., Algozzine, B., and Lim, J. H. (2021). *Doing case study research: A practical guide for beginning researchers*. Teachers College Press.

Hoozée, S., and Bruggeman, W. (2010). Identifying operational improvements during the design process of a time-driven ABC system: The role of collective worker participation and leadership style. *Management accounting research*, *21*(3), 185-198. doi: 10.1016/j.mar.2010.01.003

Kaplan, R. S., and Anderson, S. R. (2003). *Time-Driven Activity-Based Costing*. doi: 10.2139/ssrn.485443

Kaplan, R. S., and Anderson, S. R. (2007). *Time-driven activity-based costing: a simpler and more powerful path to higher profits*. Harvard business press.

Köse T. (2010). *Cost Management within the Scope of Process-Based Management*. Detay Publishing.

Krajnc, J., Logožar, K., and Korošec, B. (2012). Activity-based management of logistic costs in a manufacturing company: a case of increased visibility of logistics costs in a Slovenian paper manufacturing company. *PROMET-Traffic&Transportation*, *24*(1), 15-24. doi: 10.7307/ptt.v24i1.265

Kurt, P., Saban, M., Cankaya, F., and Annac, M. C. (2019). Time-Driven activity-based costing in the ophthalmology department of state Hospital: a case study. *Fresenius Environmental Bulletin*, *28*(4), 2754-2770.

Mayo, E. (1930). The Hawthorne Experiment. *The Human Factor*, 6.

Namazi, M. (2016). Time driven activity-based costing: Theory, applications and limitations. *Iranian Journal of Management Studies*, *9*(3), 457-482. doi: 10.22059/IJMS.2016.57481

Öker, F., and Adigüzel, H. (2010). Time-driven activity-based costing: An implementation in a manufacturing company. *Journal of Corporate Accounting & Finance*, *22*(1), 75-92. doi: 10.1002/jcaf.20646

Schuhmacher, K., and Burkert, M. (2014). *Traditional ABC and Time Driven ABC: An Experimental Investigation*. In Management Accounting Section (MAS) Meeting, New York, USA.

Siguenza Guzman, L., Van den Abbeele, A., Vandewalle, J., Verhaaren, H., and Cattrysse, D. (2013). Recent evolutions in costing systems: A literature review of Time-Driven Activity-Based Costing. *Review of Business and Economic Literature*, *58*(1), 34-64.

Škerlič, S., and Sokolovskij, E. (2019). A model for managing logistics costs throughout a product's life cycle: a case study of a multinational manufacturing company. *Transport*, *34*(5), 517-528. doi: 10.3846/transport.2019.11080

Somapa, S., Cools, M., and Dullaert, W. (2010*). Time driven activity-based costing in a small road transport and logistics company*. In Proceedings of the 2nd International Conference on Logistics and Transport & the 1st International Conference on Business and Economics (pp. 6-6), Queenstown, New Zealand.

Somapa, S., Cools, M., and Dullaert, W. (2011). The development of time driven activity-based costing models: A case study in a road transport and logistics company. *Current issues in shipping, ports and logistics*, 431-445.

Varila, M., Seppänen, M., and Suomala, P. (2007). Detailed cost modelling: a case study in warehouse logistics. *International Journal of Physical Distribution & Logistics Management*, *37*(3), 184-200. doi: 10.1108/09600030710742416

Zamrud, N. F., and Abu, M. Y. (2020). Comparative study: activity-based costing and time driven activity-based costing in electronic industry. *Journal of Modern Manufacturing Systems and Technology*, *4*(1), 68-81. doi: 10.15282/jmmst.v4i1.3840

Zhang X., and Yi H. (2008). *The Analysis of Logistics Cost Based on Time-Driven ABC and TOC*. IEEE International Conference on Service Operations and Logistics, and Informatics, 12-15 October 2008, Beijing, China. p. 1631-1635. doi: 10.1109/SOLI.2008.4682788

GENİŞLETİLMİŞ ÖZET

Giriş

Modern iş dünyası, küresel ekonominin entegrasyonuyla karakterize edilen, kurumsal liderleri giderek artan bir şekilde lojistik harcamalarını dikkate almaya zorlamaktadır. Lojistik maliyetlerini yönetmek için kullanılabilecek çeşitli yaklaşımlar vardır ve bunlar arasında Faaliyet Tabanlı Maliyetleme (FTM) yaygın olarak tanınmaktadır. FTM, bir maliyet hedefini gerçekleştirmek için gerekli faaliyetlerle ilişkili maliyetleri ölçmeye odaklanır. Geleneksel yöntemlere göre avantajları olmasına rağmen, FTM'nin bazı dezavantajları da vardır. Lojistik maliyetleri söz konusu olduğunda, yöneticileri lojistik sürecinin tamamı yerine her bir faaliyete ayrı ayrı odaklanmaya teşvik edebilir, bu da lojistik sürecin koordinasyonunda gözden kaçmalara yol açabilir. Bununla birlikte, lojistik maliyetlerinin, farklı işlevlerde ortaya çıkabileceği için özel özellikleri vardır. Lojistik sürecin etkinliği, onun bütünlüğüne bağlıdır.

FTM, zaman alıcı anketler gerektirir ve yüksek veri işleme maliyetlerine yol açar. FTM için gerekli bilgilerin elde edilmesi, örgütsel ve davranışsal engeller tarafından karmaşık hale getirilir. Çalışanlarla görüşme yapıldığında, işteki verimsizlikleri gizleme eğiliminde oldukları için yanlılıklar kaçınılmazdır. Sonuç olarak, maliyet etmenleri, tüm kaynak kapasitelerinin tam olarak kullanıldığı yanlış varsayımına dayanarak hesaplanır. Veri toplama zorlukları ve ek maliyetler, özellikle karmaşık ve çeşitli üretim hatları ve müşteri tabanlarıyla birleştiğinde, FTM'nin uygulanabilirliğini daha da zorlaştırır. FTM'nin yetersizlikleri ve uygulama zorlukları nedeniyle, daha basit, daha sağlam ve esnek bir maliyet modeli geliştirilmiştir. Bu yeni versiyon Zaman Tabanlı Faaliyet Tabanlı Maliyetleme (ZEFTM) olarak adlandırılmaktadır. Kaplan ve Anderson, bu yöntemi günlük faaliyetlerin karmaşıklığı ve değişkenliğine uyacak şekilde tasarlamıştır. ZFTM, karmaşık durumlarda bile maliyet analizlerini geliştirme potansiyeline sahiptir. Bu nedenle, ZEFTM, lojistik şirketleri için öne çıkan alternatif bir maliyetleme yöntemi olarak ortaya çıkmaktadır.

Araştırma Soruları

Bu çalışmanın araştırma soruları aşağıdaki gibidir:

- ZFTM, karmaşık lojistik faaliyetler için uygulanabilir mi?

- ZFTM, lojistik maliyetleri belirlemede FTM'den daha başarılı mı?

Metodoloji

Bu çalışma, ZEFTM yönteminin uygulanabilirliğini ve avantajlarını test etmektedir. Uygulama, lojistiği ana faaliyet alanı olarak belirleyen Türkiye'deki küçük ölçekli bir geri dönüşüm/yenileme şirketinde gerçekleştirilmiştir. Çalışma, bu yönüyle literatürdeki diğer çalışmalardan ayrılmakta ve mevcut bilgi birikimine potansiyel olarak katkıda bulunmaktadır. Maliyetler, FTM ve ZEFTM yöntemleri kullanılarak belirgin bir şekilde elde edilmekte ve farklılıklar karşılaştırmalı olarak sunulmaktadır.

Metodolojik yaklaşım, maliyet muhasebesi çalışmalarında yaygın olarak kullanılan bir yapı olan vaka çalışmasıdır. Tek bir vakayı ayrıntılı olarak incelemek, gerçek durum hakkında mümkün olduğunca anlamlı bilgi edinmek açısından daha etkilidir. Bir vaka çalışmasını detaylandırarak, ZFTM'nin karmaşık ve dinamik lojistik faaliyetler üzerindeki uygulanabilirliği kapsamlı bir şekilde gösterilebilir.

Tartışma

Sipariş işleme, envanter yönetimi, talep tahmini, taşımacılık, depolama, paketleme ve yer seçimi temel lojistik faaliyetleri olarak tanımlanmaktadır. Örnek şirketin toplama, paketleme, depolama ve dağıtım süreçleri bu şekilde sınıflandırılmaktadır. En büyük fark, dağıtım faaliyetinde gözlemlenmiştir. Bu farkın ana nedeni, FTM'deki öznel maliyet etmenlerinin, dağıtım faaliyetiyle ilgili maliyeti doğru bir şekilde belirleyememesidir. Buna karşılık, ZFTM'de zaman bazlı tek bir etmen üzerinden maliyetler tutarlı bir şekilde tahsis edilebilmektedir. Çalışmamızda, örnek şirketin lojistik maliyetleri ZFTM'de FTM'ye göre ortalama %16 daha düşük hesaplanmıştır. Bu bulgular birleştirildiğinde, lojistik maliyetlerin geleneksel yöntemlere kıyasla kullanılan tekniklere bağlı olarak abartılabileceği görülmektedir. Alanında güncel bir yöntem olan ZFTM, FTM'ye göre daha ılımlı lojistik maliyetler sunmaktadır. Bu durum, çalışmamızda rapor edilen çeşitli faaliyet türleri için de geçerlidir.

Sonuç

ZEFTM'nin geliştirilmesi üç ana nedenle gerekçelendirilebilir: (1) FTM'de maliyetleme modelini oluşturmak ve güncellemek zordur. (2) FTM, üretimdeki değişimlere yanıt veremez. (3) FTM'de maliyet etmenlerinin seçimi öznel olabilir ve göreceli doğası nedeniyle hatalara eğilimlidir. ZEFTM, FTM'nin eksikliklerini ele alır ve faaliyetleri tek bir etmen ile ifade ederek uygulanmasını kolaylaştırır. Bu, her faaliyetin maliyetinin zaman bazlı olarak diğerleriyle karşılaştırılmasına olanak tanır. Ayrıca, pratik kapasiteyi dikkate alan bir model önermek, ZEFTM'nin seleflerine göre önemli bir avantajıdır. Örnek şirketin verilerine dayanan hesaplamalar bu yönü yansıtmaktadır.

Öneriler

ZEFTM'de, bir faaliyetin süresini belirlemek için zaman denklemleri kullanılır. Ancak, bir alt faaliyete veya sürece harcanan zaman, gelişmiş teknolojiler sayesinde daha kolay ve doğru bir şekilde tespit edilebilir. Nesnelerin İnterneti, otomasyon, nesne tanıma için dijital görüntü işleme teknikleri ve Radyo Frekansı ile Tanımlama ve Küresel Konumlama Sistemi gibi ileri teknolojiler, zaman denklemleri için neredeyse kesin sonuçlar sağlayabilir. Öte yandan, yeni teknolojiler maliyet tahsis ihtiyacını da ortadan kaldırabilir. İleri teknolojileri kullanarak ZEFTM aracılığıyla bir şirketin lojistik maliyetlerini inceleyen veya herhangi bir maliyet tahsis yöntemi olmadan lojistik maliyetlerin belirlenip belirlenemeyeceğini araştıran gelecekteki çalışmalar, literatüre değerli katkılar sunabilir.