TDABC FOR A MANUFACTURING ENVIRONMENT: A CASE STUDY

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Abstract

Costing system is an essential part of a company. Determining the accurate cost of a product or service is extremely important for the profitability and performance of a company. Over the years, different approaches and models have been developed to estimate the cost of the product manufactured. However, their models were found to be inadequate in the correct value of the product cost. In the last decade, activity-based costing (ABC) has been successfully adopted by many companies worldwide. Nonetheless, because of its high maintenance and setup cost, it has been abandoned and a new time-driven activity-based costing (TDABC) model has been developed. Though adopted by many large scale-manufacturing industries, TDABC has not been implemented in small scale manufacturing companies due to unavailability of resources and also ignorance about its implementation. This paper presents a model for the application of TDABC in the small scale manufacturing industry. The model is implemented in a furniture manufacturing company for the estimation of product cost. The cost obtained from the TDABC is compared with the traditional costing system and established the accuracy of TDABC over the traditional costing system. Along with the case study, this paper also discusses the different data results obtained from TDABC and its utility for the managers and the decision makers.

Keywords

activity based costing • time-driven activity-based costing • manufacturing industry

1. Introduction

Competitive markets in the manufacturing sector are characterized by permanent changes, constant innovation and cost reduction policies. Therefore, to be successful in this new environment, companies must react quickly and manufacture high quality and low cost product. Companies that are managing cost reduction in production processes have to implement effective accounting systems in order to calculate the impact of the improvements on the cost of products (Chiarini, 2014). Activity based costing (ABC) is the most successful approach to costing that has overcome the shortcomings of traditional costing (Mota, Benzecry, & Qassim, 1999). ABC is good at managing costs by providing more accurate product cost information (Jusoh & Miryazdi, 2015). Hence, many organizations had adopted ABC for cost accounting. But, many organizations are abandoning their ABC models because of high maintenance, setup cost and employee’s irritation (Kaplan & Anderson, 2003).

The information needed for implementing ABC is costly and small manufacturing firms are typically constrained financially (Roztocki, Porter, Thomas, & Needy, 2004). So many small scale-manufacturing industries are still using traditional costing systems. The majority of traditional cost systems use an arbitrary method of either a single plant wide overhead rate or several departmental overhead rates according to output volume to allocate factory overhead cost to products or services (Sheu & Pan, 2009). But to survive in this cut throat competition, small scale manufacturing industries need a system that can be used for performance measurement. Information produced by ABC is mostly in such a form, that it can be used directly in performance measurement (Koota & Takala, 1998). Therefore, many efforts were taken to implement ABC in small scale manufacturing industries. Still many industries are struggling with ABC. Therefore, Kaplan and Anderson (2003) proposed time-driven activity-based costing (TDABC). TDABC is a complicated name for a simple concept: Total Cost = Cost Rate x Time (Hennrikus, Waters, Bae, Virk, & Shah, 2012).

This paper discusses how TDABC can be applied in small scale manufacturing company. ABC concepts followed by TDABC concepts is discussed initially and then extended to analyse the previous case studies on TDABC and difficulties in its implementation. Thereafter, how TDABC can be implemented in small-scale companies is explored and a model
for implementation is proposed. Finally, a case study of implementation in the steel furniture manufacturing industry is presented.

2. Theoretical background

Costing is important from the beginning of civilization. Large methods of costing have evolved over time. In the last decade, the activity-based costing (ABC) system has gained a lot of importance and application. The evolution of TDABC from ABC is elaborated in the following paragraphs.

Activity-based costing
ABC is a tool for improved product costing and cost management practices. It was pioneered by (Cooper, 1988a; Cooper, 1988b; Cooper & Kaplan, 1988). ABC is a two stage procedure used to assign an overhead cost to products and services produced (Hilton, 2005). ABC assigns overhead cost and indirect cost first to activities and then to products or services. Use of ABC is associated with higher quality levels and greater improvements in cycle time and quality, and is indirectly associated with manufacturing cost reductions through quality and cycle time improvements (Ittner, Lanen, & Larcker, 2002) Therefore, since ABC’s introduction in the 1980s, many authors took the efforts for the implementation of ABC and presented case studies (Gunasekaran & Sarhadi, 1996; Sohal & Chung, 1998; Tornberg, Jämsen, & Paranko, 2002). As a result of this, implementation of ABC has grown rapidly in manufacturing industries. Gunasekaran and Singh (1999) refer that ABC has an important role in performance improvement of small companies. Since then, there is vast literature that deals with the design and implementation of ABC in small scale manufacturing industries (Bharara & Lee, 1996; Gunasekaran & Singh, 1999; Needy, Nachtmann, Roztocki, Warner, & Bidanda, 2003; Roztocki et al., 2004).

In spite of these efforts, many organizations have abandoned their ABC model because of its high implementation costs and employees’ reluctance. Further, Gosselin (2006) has given following reasons for failure of ABC:

- high implementation cost;
- information technology inadequacy;
- lack of senior management commitment;
- difficulties in linking cost drivers to individual products;
- amount of work quantitative information on cost drivers.

TDABC was evolved to overcome these difficulties.

Time-driven activity-based costing
The TDABC method was presented as a revolutionary method in the field of determined costs (En-nhaili, Meddaoui, & Bouami, 2015; Meddaoui & Bouami, 2014). TDABC model simplifies the costing process of ABC through the deletion of the need of interviewing and polling staff to assign resources to activities, before assigning them to the cost objects (orders, products, customers) (Kaplan & Anderson, 2007). Demeere, Stouthuysen, and Rooihoof (2009) and Stouthuysen, Swiggers, Reheul, and Rooihoof (2010) proposed the stepwise approach for implementing TDABC.

- Identify the various activities (resource groups, departments)
- Estimate the total cost of each activity
- Estimate the practical capacity of each resource group
- Calculate the unit cost of each activity
- Determine the time required each time the activity is performed
- Multiply the unit cost of each activity by the time estimate for the event

Because of these advantages, many large scale-manufacturing companies adopted TDABC approach.

Previous case studies on TDABC
Many researchers conducted the case studies of TDABC implementation at different industries. These case studies are related to pig production, casting manufacturing, electronic product manufacturing, wooden toys manufacturing, bicycle manufacturing, auto part manufacturing and precision casting factory. All these companies are medium or large scale in nature. The detail of these case studies is presented in Table 1. The researchers have opined that TDABC provides more relevant information for capacity utilization, can capture the cost of different products in product mix, and is easier than traditional costing, particularly ABC.

Difficulties in implementing TDABC
Despite many implementation efforts, researchers faced difficulties in implementing TDABC. Difficulties faced by different authors are given in Table 2.

The constraints in implementing TDABC include estimating time for non-continuous activities, difficulties in the implementation of practical capacity and cost estimation, if direct observation of activity is not possible. The small manufacturing companies are not willing to adopt the TDABC
3. Developing the TDABC model

For the implementation of TDABC in small scale manufacturing company, authors have developed a model, as outlined below, considering the following assumptions.

- The company manufactures different products.
- The company is a job shop so the variation in products occurs.
- Multiple operators and machines are involved in manufacturing the product.
- Presently, traditional costing system is followed.

The proposed model consists of two steps, first determination of unit cost (see Figure 1) and second distribution of activity cost on the product (see Figure 2).

### Determination of unit cost

In this step, the list of overheads is prepared. For this model, the overhead term includes all the consumables while performing the activity and the infrastructure resources used by the activity. The cost of the overhead is obtained from the trial balance sheet of the company. Then the quantity of...
resource driver for each overhead is determined. Resource driver is a measuring unit of the overhead. The unit cost of the overhead is determined by dividing the cost of resource by the quantity of the resource driver. The overheads are distributed on the activity based on consumption of these resources through resource driver. Sum of the cost of all overheads on activity is the cost of the activity. Often practical capacity is estimated as a percentage, say 80% or 85%, of theoretical capacity. This system is more suitable in assembly lines or continuous system. But in many small scale industries, some machines are used only for some specific work or operation. In such a case, it is very difficult to determine theoretical capacity. Hence, the practical capacities of such activities can be measured from direct observation or from the job card. The unit cost of the activity is obtained by dividing the cost of activity by the practical capacity.

**Distribution of activity cost on product**

In the second step, the product is identified and list of activities consumed by the same product is prepared. The time consumed by each activity for the same product is determined from the time equation. The time equation for an activity is a function of n potential factors differentiating this activity, expressed as:

\[ T = \beta_0 + \beta_1 X_1 + \ldots + \beta_n X_n \]  

(1)

Where:
- \( T \) - time needed to perform an activity,
- \( \beta_0 \) - standard time for performing the basic activity,
- \( \beta_i \) - estimated time for the incremental activity \( i \), (\( i = 1, 2 \ldots n \)),
- \( X_i \) - quantity of incremental activity \( i \) (\( i = 1, 2 \ldots n \)).

The time required to perform the activity is obtained either by direct observation or by interviews.

The cost of activity is obtained by the product of the unit cost of the activity (from step 1) and the time consumed by the activity. The sum of the cost of activities will give the total cost of activities consumed by the product. The final cost of the product is obtained by adding labour cost and raw material cost in the total cost of activities.

4. Case study and discussion

The company under study is located in central India and is a small-scale manufacturer of hospital, office and home furniture. At the time of the study, the company had 25
Step 1
In order to implement TDABC, the list of overheads is prepared. The overheads are identified from the trial balance sheet and direct observation of activity. Total 22 overheads were identified. Building rent, building maintenance, power consumption, machine maintenance cost, chemical consumable, and so on are some of the identified overheads. The cost of these overheads is determined from the trial balance sheet of the company. Then, for each overhead, resource driver is determined. The resource driver is determined based on the consumption unit of the driver. For example, the resource driver for building maintenance and rent is the surface area; for power consumption, it is watt; for machine maintenance, it is time; for chemical consumable, it is kilogram. The value of each resource driver is determined. The value of surface area is the available total surface area of the building; for watt, it is the total wattage consumed in a year. As a balance sheet is prepared for a year, the watt consumed in a year is considered. Unit cost for each overhead is determined by dividing the cost of overhead by resource driver. The unit cost of building maintenance overhead is the division of cost of overhead Rs. 12,466/- and resource driver 13,691.69 ft². Therefore, the unit cost of building maintenance overhead is 0.91 Rs/ft². Similarly, the unit cost of each overhead is determined. Then, all these overheads are distributed on the activities based on the consumption of the resource driver. Surface area occupied by welding activity is 500 ft². So, the cost of welding activity constitutes building maintenance Rs. 455.24/-. Where 455.24 is a product of unit cost of building maintenance overhead 0.91 Rs/ft² and resource driver 500 ft². The cost of an activity is the sum of all the overheads consumed by it. Cost of some activities is given in Table 3.

Practical capacities of such activities can be measured in terms of time and it is obtained from direct observation and from the job card. Again the capacity is measured for the period of one year. The unit cost of an activity is calculated by dividing the total cost of activity by the practical capacity of each resource group. For example, the unit cost of treatment activity is the division of Cost of treatment activity Rs. 460,917.94/- and practical capacity of treatment activity 114,750. So, the unit cost of treatment activity is 0.25 (see Table 3).

Step 2
A time motion study was conducted to determine the required time for an activity. In a time motion study, one activity is divided into number of sub activities. Then, time for each sub activity is an average time of number of observations. Time equations are framed from these observations. Time equations of important activities are given in Table 4. For a grinding activity, the time equation is 0.792 + 1.326 (number grinding points), where, = 0.792 is the fixed time required for the activity. It includes the time required for initial setup, starting and turn off machine. Similarly, = 1.326 is the time required for grinding each point.

The cost of each activity consumed by the product is a product of the unit cost of each activity and the time required for the activity. The total cost of the product is the sum of the cost of each activity. For example, the time consumed by HTRC-19 in treatment activity is 52.5 min and unit cost of treatment activity is 0.25. Hence, the total cost of treatment activity consumed by the product is a multiplication of 52.5 and 0.25.

The cost of the product is a sum of the cost of each activity consumed by the product, direct labour cost, direct

<table>
<thead>
<tr>
<th>Activity</th>
<th>Activity cost (A)</th>
<th>Practical capacity supplied (B)</th>
<th>Unit activity cost (C = B/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembling</td>
<td>34,363.5</td>
<td>94,500</td>
<td>2.75</td>
</tr>
<tr>
<td>Buffing</td>
<td>26,712.8</td>
<td>67,500</td>
<td>2.53</td>
</tr>
<tr>
<td>Coating</td>
<td>121,728</td>
<td>309,375</td>
<td>2.54</td>
</tr>
<tr>
<td>Drilling</td>
<td>730,99.6</td>
<td>202,875</td>
<td>2.78</td>
</tr>
<tr>
<td>Grinding</td>
<td>206,219</td>
<td>526,125</td>
<td>2.55</td>
</tr>
<tr>
<td>Handling</td>
<td>8,499.82</td>
<td>23,625</td>
<td>2.78</td>
</tr>
<tr>
<td>Notching</td>
<td>50,290</td>
<td>128,250</td>
<td>2.55</td>
</tr>
<tr>
<td>Packing</td>
<td>18,872</td>
<td>45,000</td>
<td>2.38</td>
</tr>
<tr>
<td>Pipe Bending</td>
<td>48,527.4</td>
<td>123,750</td>
<td>2.55</td>
</tr>
<tr>
<td>Pipe Cutting</td>
<td>60,294.1</td>
<td>153,000</td>
<td>2.54</td>
</tr>
<tr>
<td>Repairing</td>
<td>1,619.01</td>
<td>4,500</td>
<td>2.78</td>
</tr>
<tr>
<td>Shearing</td>
<td>18,598.6</td>
<td>47,250</td>
<td>2.54</td>
</tr>
<tr>
<td>Sheet Pressing</td>
<td>75,580.7</td>
<td>192,375</td>
<td>2.55</td>
</tr>
<tr>
<td>Sheet Punching</td>
<td>14,906</td>
<td>37,125</td>
<td>2.49</td>
</tr>
<tr>
<td>Treatment</td>
<td>460,918</td>
<td>114,750</td>
<td>0.25</td>
</tr>
<tr>
<td>Welding</td>
<td>448,148</td>
<td>816,750</td>
<td>1.82</td>
</tr>
</tbody>
</table>
material cost and summation of overheads cost consumed by the product. Therefore, in this example, the total cost of the product is Rs. 6,371.2/-. The complete costing procedure is mathematically represented by equation 5. Same product cost calculation is shown in Table 5.

5. Results and discussion

In the traditional costing system, only 6 activities were considered, whereas in TDABC system, 52 activities were considered. These extra 46 activities represent about 71.59% of all the resources. Hence, TDABC system provided accurate and relevant information to the management, which assisted them in product analysis (Section 5.1), operational improvements (Section 5.2), making a profitability analysis of each product (Section 5.3), and deciding on future investments (Section 5.4).

Product analysis

TDABC provides the detailed decomposition of the cost. This information is useful for identifying higher cost consuming activities. Figure 3 indicates the pareto chart of cost consumed by activities for the manufacturing of HTRC-19. It indicates that the contribution of grinding activity is the highest and it is contributing 53.3% of the total cost of activities. Therefore, grinding activity should be analysed first to improve the profitability.

Operational improvements

The TDABC approach is associated with time equation. This offers some specific advantages, as this time equation provides detailed distribution of time in different sub-activities. This provides the clear information to management about the

Table 4. Time equations for activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time Equation ( (T=\beta_0+\beta_1 X_1+ \ldots +\beta_n X_n) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffing</td>
<td>0.162 + 0.084 (number of times chemical is applied) + 3.72 (buffing length per feet)</td>
</tr>
<tr>
<td>Coating</td>
<td>0.456 + 1.442 (number of times the booth is cleaned) + 0.354 (surface area per square feet)</td>
</tr>
<tr>
<td>Drilling</td>
<td>0.198 + 1.008 (number of drills on a work piece) + 0.072 (number of times work piece moved)</td>
</tr>
<tr>
<td>Grinding</td>
<td>0.792 + 1.326 (number grinding points)</td>
</tr>
<tr>
<td>Notching</td>
<td>0.1014 + 0.108 (set parameter in machine) + 0.567 (number of operations)</td>
</tr>
<tr>
<td>Pipe Bending</td>
<td>0.39 + 0.234 (number of change of dies) + 3.192 (number of bends)</td>
</tr>
<tr>
<td>Pipe Cutting</td>
<td>For pipe: - 0.426 + 2.85 (number of cuts)</td>
</tr>
<tr>
<td></td>
<td>For flat and angle: - 0.666 + 1.26 (number of cuts)</td>
</tr>
<tr>
<td>Shearing</td>
<td>0.642 + 1.632 (number of cuts on a sheet)</td>
</tr>
<tr>
<td>Sheet Pressing</td>
<td>0.33 + 2.076 (number of bends) + 0.162 (number of alignment of sheet)</td>
</tr>
<tr>
<td>Sheet Punching</td>
<td>0.108 + 3.126 (number of die change) + 3.29 (number of punches)</td>
</tr>
<tr>
<td>Welding</td>
<td>2.664 + 3.465 (number of jig used) + 0.9 (number of parts placed in jig) + 5.4 (per inch welding length)</td>
</tr>
</tbody>
</table>

Table 5. Distribution of activity cost on product and calculation of product cost

<table>
<thead>
<tr>
<th>Product</th>
<th>Activity</th>
<th>Unit activity cost ((C))</th>
<th>Time required for the activity ((D))</th>
<th>Total activity cost consume by product ((E = C \times D))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatment</td>
<td>0.25</td>
<td>52.5</td>
<td>13.1</td>
</tr>
<tr>
<td></td>
<td>Coating</td>
<td>2.5415237</td>
<td>30.0</td>
<td>76.2</td>
</tr>
<tr>
<td></td>
<td>Handling</td>
<td>2.7794708</td>
<td>52.5</td>
<td>145.9</td>
</tr>
<tr>
<td></td>
<td>Welding</td>
<td>1.8225013</td>
<td>3.8</td>
<td>6.8</td>
</tr>
<tr>
<td>HTRC-19</td>
<td>Grinding</td>
<td>2.5512902</td>
<td>240.0</td>
<td>612.3</td>
</tr>
<tr>
<td></td>
<td>Pipe cutting</td>
<td>2.5375603</td>
<td>75.0</td>
<td>190.3</td>
</tr>
<tr>
<td></td>
<td>Drilling</td>
<td>2.7753224</td>
<td>37.5</td>
<td>104.1</td>
</tr>
<tr>
<td></td>
<td>Direct labour</td>
<td></td>
<td></td>
<td>712.9</td>
</tr>
<tr>
<td></td>
<td>Direct material</td>
<td></td>
<td></td>
<td>4,509.5</td>
</tr>
<tr>
<td></td>
<td>Total cost of product</td>
<td></td>
<td></td>
<td>6,371.1</td>
</tr>
</tbody>
</table>
activities that are consuming more time and cost. Further, it also provides the detailed information about the sub-activity that is consuming more time. Consequently, a TDABC model offers operational insights concerning activities and their added value. This way, the management could take appropriate actions to lower the time required for some actions. This also introduced an open communication between the management and the employee for the operational improvements and internal benchmark exercise. For example, Figure 4 shows the time consumed by different activities for manufacturing ‘HTRC-19’. It indicates that the time required for the grinding process is more as compared to other processes. Hence, the grinding activity is reducing the production rate of this product as well as it is consuming more cost in the production (see Table 5). TDABC is using time as the cost driver. Therefore, the higher production time is responsible for the higher cost of grinding. The time of the activity is estimated using time equations (see Table 4). It indicated that the time consumed by grinding activity is dependent on the number of grinding points. The number of grinding points is dependent on the welding quality, sharp cutting edges and uneven surface. The production managers can focus on parameters of activities to reduce the time and the cost. In this way, it helps the management to identify the bottleneck in manufacturing that causes high production time and high manufacturing cost.

A profitability analysis of products
Product cost of the traditional costing system is compared with the TDABC system (see Table 5). The comparison shown in Table 5 indicates that in the case of the products, HBAHTB-2A, HTB-3A, WP200100, WP150100, DP500100 and DP500200 actual product cost is less than the cost estimated by the traditional costing system. These products are more profitable. Whereas, in the case of HTRC-19, B550500100 and B550550200, the actual product cost is greater than the cost estimated by the traditional costing system. Therefore, these products are unprofitable. This difference in cost is because of improper distribution of overhead cost in the case of traditional costing system. Management agreed about the results obtained through TDABC based on their experiences.

Future investment decisions
Apart from the above analysis, TDABC provides information for future investment decisions. Managers in the company paid special attention to the TDABC data in updating plant setup. For example, the cost of grinding process is the highest in all the overheads (see Table 5). Therefore, the management concludes that the welding process needs to be improved so that the grinding time will reduce. Moreover, from the time equation, the management found that the fixed time (∝) required in an activity is greater. Therefore, they focused on the jig and fixture locking arrangement to reduce the initial work piece holding time. In this way, the TDABC system played a significant role in the prioritization and cost justification of improvement projects.
Use of TDABC would help management make following decisions:
• Which products or services to offer?
• How to make a product?
• When to make a product?

6. Conclusions and outlook

In this paper, we have given a framework for the implementation of TDABC and managerial impact of TDABC in a small manufacturing environment. This system is more suitable for small scale manufacturing companies, involving many activities with complex time drivers. The developed model structure was clear and understandable, and the implementation went smoothly.

The TDABC system helps the managers and department heads to identify and analyse the underlying activities that drive the overhead costs. This model also identifies the area for operational improvement. This helps the company to reduce the cost of the product.

A profitability analysis of 9 products was carried out. The cost of traditional costing system was compared with the cost from the TDABC model. It was found that only 6 products were profitable, whereas the remaining 3 products were causing loss to the company.

TDABC also helps the managers to find the bottleneck in manufacturing. This information is helpful for decisions about future investment and expansion of the manufacturing setup.

Application of TDABC model for small-scale manufacturing environment, for the first time, has led to the enrichment of literature as:
• It demonstrates the application of TDABC in a small scale manufacturing industry.
• It discusses the results and its utility in a small scale manufacturing industry.

Future scope of work:
• This model can be applied in different sectors.
• A software package based on this methodology can be developed.

References


