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Mem. Muroran Inst. Tech., 65(2015) 7-14

Analysis of Wooden Toy Manufacturing Costs Through the Application of a Time-Driven Activity-Based Costing System

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(Received 26th October 2015, Accepted 2nd February 2016)

Abstract

The case study company, which manufactures wooden toys, encounters problems when fixing its product prices, since its experienced owners tend to dictate the prices of all the products, yet do not have available the appropriate product price and cost data. Currently, the company's product costs are calculated using traditional accounting methods, but these are unable to accurately record the costs associated with the resources used and activities that occur during manufacture. Furthermore, when the case study company changes any of the resources used to make its products, it is not able to adjust prices accordingly. The objectives of this study were to analyze the manufacturing costs incurred at the case study company using Time-Driven Activity-Based Costing (TDABC). The research began by collecting data related to the current production costs of the highest selling product (draughts sets). TDABC requires estimates to be made of two key parameters: (1) the unit cost of supplying capacity, and (2) the time required to perform a transaction or an activity. The next stage in the research involved analyzing costs using the TDABC steps. The results showed that applying the TDABC method to product costing is more consistent with the actual use of resources at the case study company than when using traditional costing methods. The study company; therefore, has the potential to use this method to more accurately determine the appropriate prices for its products. In addition, the study identified those activity centers mostly related to manufacturing costs. Based on this information, and as part of any future research, it will be possible to identify and implement the methods or guidelines needed to reduce these costs.

Keywords: Manufacturing costs, Time-Driven Activity-Based Costing, Wooden toys

1 INTRODUCTION

Due to today's increasingly competitive market conditions, consumers have more choice when deciding to purchase a product or service, and so to stay competitive, businesses need to adapt accordingly. Manufacturing costs have also increased in recent years due to increases in the costs of raw materials and those services bought-in from other companies, as well as increases in staff wages. However, to raise the price of a good raises the risk of losing customers to other businesses offering lower prices and so losing market position, as well as losing the ability to compete.

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If the selling price for products is either too low or too high, it will impact upon the ability of a company to generate a profit, and losses may even be experienced. Therefore, it is important for companies to produce accurate cost estimates, so that they can sell at an optimal price, as well as understand where the manufacturing process needs to be optimized.

The case study company manufactures wooden toys, but encounters problems when fixing its product prices, since its owners, although experienced, tend to dictate price levels, yet do not have available the appropriate product price and cost data. Currently, product costs are calculated through the use of the company's traditional accounting methods, and these methods are unable to accurately record the costs associated with resources and activities. Furthermore, when the case study company changes any of the resources it uses to make a product, it cannot adjust its prices accordingly.

Data from interviews held with the business owners shows that the production costs for wooden toys in 2013 included a direct labor cost of 51%, production overheads of 38% and direct materials costs of 11%, as shown in Figure 1.

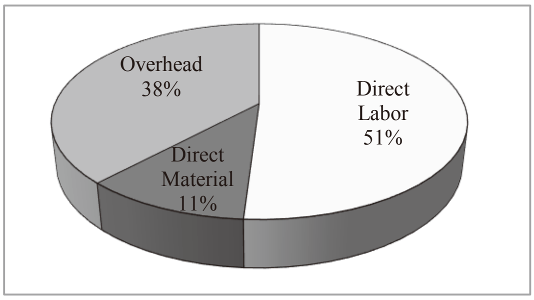

Figure 1 Production costs for the case study company; broken down by direct labor, direct materials and manufacturing overhead costs for 2013.

Time-Driven Activity-Based Costing (TDABC) has been applied across many organizations and is known for its variety of potential uses and its precise results. Applying TDABC ensures product costs are more accurate and consistent with a company's resources use patterns, since the method is mainly based on actual activities and recognizes that activities consume production resources. The objectives of this study were to identify and analyze manufacturing costs at the case study company using TDABC. The study company has the potential to use the results of this study to better determine the prices of its products. This will also make it possible for the company to identify which products generate the most profit. Furthermore, once the company has analyzed its product costs using TDABC, it will be able to develop the methods and guidelines needed to reduce manufacturing costs.

2 TDABC: CONCEPT AND APPLICATIONS

This section will discuss the theory and relevant research related to TDABC.

2.1 Principles of the costing systems

The basic principles of the costing systems are as follows:

2.1.1 Definition and meanings of cost

Cost is the value of resources, measured in economic terms, used to produce the product or service [1]. There are three types of cost: direct materials, direct labor and overhead costs. By calculating the costs of the direct materials and direct labor costs used in a production process, we can determine these costs associated with producing the product or service. However, overhead costs cannot be identified directly in relation to a good or service, and this can lead to the calculation of production costs not matching with the actual costs [2].

2.1.2 Activity-Based Costing (ABC)

The ABC costing method is mainly based on actual activities and recognizes that activities consume production resources. The direct materials and direct labor costs can be allocated into a product or service directly. The overhead costs, on the other hand, are determined based on the allocation of the costs of resources used in activities based on criteria or drivers relevant to those activities. Therefore, the costs of products or services that use up a large amount of activities will be higher than for those products or services that do not [3].

2.1.3 Time-Driven Activity-Based Costing (TDABC)

TDABC method has been developed from the traditional ABC method which requires significant processing in data collection and cost allocation. The TDABC method uses time as criteria or key measurement variable for the allocation of costs, because all costs involve time [4]. TDABC requires estimates to be made of two key parameters: (1) the unit cost of supplying capacity, and (2) the time required to perform a transaction or an activity. The TDABC method can then be used to produce results quickly. It can also be easily modified to incorporate other approaches. The cost calculation methods used by TDABC reflect the use of a variety of time equations to determine production and consumption behaviors, providing more accurate costs than conventional methods. However, it should be noted that TDABC is not as accurate as ABC.

2.2 Comparison between ABC and TDABC

TDABC is unlike ABC, since ABC gathers together the total cost of all the activities before allocating these to the products being produced based on cost driver volumes. In contrast, when using TDABC, the capacity cost rate is determined first, then multiply this by the cost driver for each individual activity, meaning the cost of each activity can be clearly seen [5]. TDABC uses a simple calculation with only two important variables included: the capacity cost rate and the actual time spent on each process [6]. The list below describes what advantages TDABC has over ABC [4]:

1. It is able to be used easily and quickly.
2. It is able to be applied with and work alongside a company's own information systems (such as ERP and customer relationship management systems).
3. It can be applied using more than one cost driver for transactions and purchase orders.
4. It can be applied more frequently (e.g. monthly).
5. It is able to provide information on process efficiency and capacity utilization.

6. It can be applied in planning capacity and budgeting activities.
7. It can be used by different industries, including those with complex processes, systems or organizational structures.

The researchers for this study were able to identify these advantages when using TDABC, since the case study company has a highly complex and sophisticated manufacturing process, so to collect the in-depth information needed to apply the ABC method would have been very difficult, using up a lot of time and money. It would also have been difficult to choose the variety of cost-drivers suitable for the calculation of costs for each activity.

2.3 The application of TDABC

TDABC has been used in many organizations and has been acknowledged for its wide variety of potential uses and precise results. One example of its use comes from the Belgian Logistics Company [5], which applied TDABC because it saw that though its gross margins were fixed and sales were growing, the overall return on sales was decreasing. This loss in profit caused the management team to demand that the company measure costs and profits more accurately. As a result, the company implemented TDABC and was able to identify the time spent on specific activities and the causes of this, plus why transportation costs were so high (the team found the company was delivering many small parcels to many separate delivery points). After reducing the number of parcel deliveries and delivery points, profits increased. The information provided by TDABC was also used to set the customer fees. The study concluded that TDABC could collect complex time-based activity details covering all 7,000 of the company's customers, and that this would allow the company to respond to the needs of each customer's individual logistics requirements. Moreover, this information could be relied upon [4].

Another study of a US dairy production factory also made similar findings related to TDABC [7]. This study concluded that the time equation used by the TDABC system can help predict time spent on specific activities; even in light of the varying specifications required by each order, and so improve reliability. TDABC time equation is able to incorporate all relevant limitations within a single equation. Such restrictions, those which appear in the TDABC timing equation, cannot be considered within ABC [7]. As many companies wish to minimize their operating costs, so it is essential they are able to understand the actual cost of producing their products, and TDABC can help in this respect [4]. Some companies have even applied TDABC in support of a growth strategy, as it enhances their ability to generate a profit by first measuring costs and profits accurately [8].

A review of the literature and previous research relating to TDABC shows that both the TDABC and ABC methodologies have advantages and disadvantages. The choice of which system to use should be based on which method a company thinks will be most fit for purpose.

3 INFORMATION OF THE CASE STUDY COMPANY

The case study company consists of a factory housed in a two-story building. The front is open-ended, for drying wood, while the first floor is the production area and the second floor is a warehouse. The company was first established in September 1981, and was registered as a limited company on 13th January 2011 with registered capital of one million Baht. The business started as a small manufacturing business with about 50 employees; three in the management team and 47 skilled laborers. The company's products include 500 different wooden toys and games made from the 'rain tree', as shown in Figure 2. These products include games such as Draughts, Tangram, Jenga and Chinese checkers, and a Notched stick game. Production of each of these products involves a different process, with the complexity varying based on the labor and machine requirements. The different stages include oven-drying/external drying of the fresh wood, then sawing, scooping, inspecting, polishing and packaging the product. Multiple products are sold, both in Thailand and abroad, such as in the United States.

Figure 2 Wooden toys produced by the case study company

The company's management lacks a good level of knowledge and understanding of many aspects of a modern manufacturing management system. The main problem is the lack of knowledge that exists on the actual production costs incurred by the company, as costs are estimated based on the judgment and experience of the owners.

4 RESEARCH METHODOLOGY AND RESULTS

This research started by collecting data related to orders, receipts and disbursement slips from within the case study company. Observations were made and data collected from actual work stations. Forms were prepared and data were recorded in relation to the consumption and cost of raw materials, labor costs, and manufacturing overhead costs, as well as production volumes. The data was collected in November 2014. After gathered the data, a Flow Process Chart along with a Flow Diagram were created, to provide an overview of the case study company's production processes.

To calculate costs using the TDABC method, there are eight stages to follow, as shown in Figure 3.

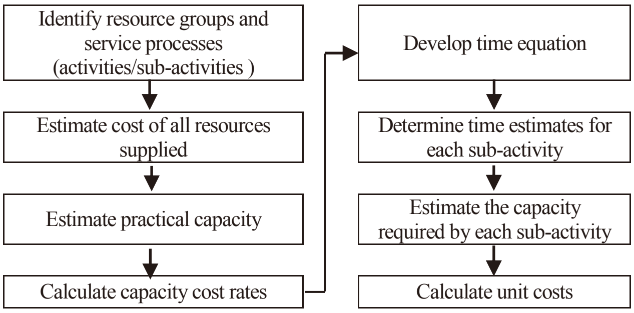

Figure 3 Process used for applying TDABC [5].

To start, production activities (activity centers/sub-activities) have to be identified. Then the estimates of the costs of all resources used and the acceptable capacity are required for the capacity cost rate calculation. To calculate the production costs, a time equation has to be created for each activity center. After that, the estimated time for each activity is determined, and the capacity demand of each activity center also calculated. Finally, the cost per product unit is derived [5].

The research methodology and results are as follows:

4.1 Production activities used (activity centers/sub activities)

The first step taken using the TDABC method is to analyze and identify the manufacturing activities taking place, in order to understand their scope and the specific sequence of events taking place, because all activities vary but have a purpose.

In the case study company, the first step in the manufacturing process is oven-drying the wood and adding insect repellent. The wood is then left to dry before being stored in the warehouse. After that, the wood is reduced in size through sawing, before being sanded to get rid of any coarse grain, knots or holes, as required for making the product. The wood is then lightly polished to give it a smooth surface. After that, the product is assembled from the different parts and then painted, to create the finished product. The products are then closely inspected before being packed. The packed products are then either transferred to the warehouse or dispatched to the customer. This process is shown in Figure 4.

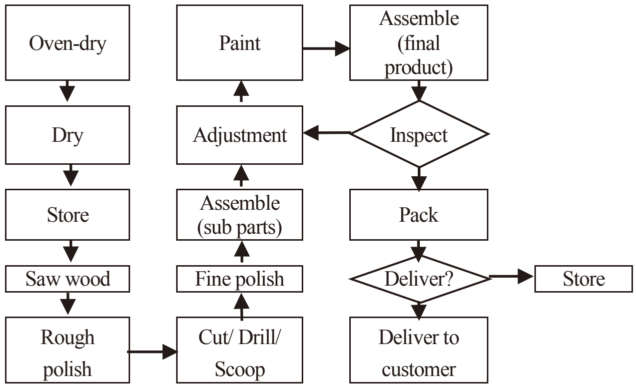

Figure 4 Production process at the case study company

For this study, the researchers calculated the production cost of making draughts, as it is the company's highest selling item. The production of this product can be divided into three activity centers, as follows:

1. For the wood preparation activity center, the raw materials are taken from the warehouse and oven-dried, then after cooling are laid outside to dry, before being returned to the warehouse for storage.
2. For the wood processing activity center, the wood is taken out of storage to be sawed, after which it undergoes rough polishing, then is cut, drilled and has holes punched in it. It is then fine polished using sandpaper.
3. For the retail packaging and delivery activity center, the polished wood sub-parts are assembled together, then decorated using paint; for example, the board game pieces and draughts pieces. The final product is then assembled and inspected, before being packed in a sealed bag and left to dry. It is then stored in a holding area prior to delivery.

This paper explains in details on how to apply the TDABC method for the cost calculation in activity center 1─wood preparation only. The same TDABC process also applies within activity centers 2 and 3. The activity center 1–wood preparation process consists of six sub-activities: (i) employees transfer the wood from storage to the oven, (ii) wood is placed in the oven and oven-dried for 24 days, (iii) wood is allowed to cool and then employees transfer the wood from the oven to the drying area, (iv) wood is dried for another seven days, (v) employees transfer the wood from the drying area to the store, and (vi) wood is stored in the warehouse (post-drying).

4.2 Estimated total cost of the resources used (cost of all resources supplied)

If the resources used all fall under the same activity, costs can be allocated directly to that activity. However, if resources are used for several activities, an allocation method based on the appropriate cost-driver has to be used. In this study, the researchers allocated resources based on the types of resource used for each activity, these being divided into two groups: (i) labor costs, and (ii) the cost of equipment, machinery, and other equipment. Details of the costs incurred in each study sub-activity (activity center 1–wood preparation) are as follows:

1. Transporting the wood from the warehouse to the oven: Requires three employees at a cost of 7,644 Baht each per month, giving a total of 22,932 Baht. However, the sub-activities for taking the wood to the drying area and taking the wood back at the warehouse use the same amount of labor and work resources, so the average cost of all these activities is 7,644 Baht per each sub-activity per month. Two vehicles incur depreciation and maintenance costs at 176 Baht each per month, giving a total of 352 Baht per month. This means the total cost of this sub-activity is 7,996 Baht per month.

2. Drying the wood in an oven for 24 days and switching the oven on and off: This step requires one employee at a cost of 7,644 Baht per month. Since this one employee handles three sub-activities, including setting-up the oven, drying and storage after drying, and as these take up an equal amount of time, so the average is 2,548 Baht per month per sub-activity. Depreciation of the oven is 1,666.67 Baht per month and the electricity costs are 20,000 Baht per month. This gives a total cost for this sub-activity of 24,214.67 Baht per month.

3. Transferring the wood from the oven to the drying area for drying: The calculation process for this is the same as for taking the wood from the warehouse to the oven. The total cost of this activity is; therefore, 7,996 Baht per month.

4. Drying the wood for another seven days: This stage involves one employee at a cost of 7,644 Baht. Since this one employee handles three sub-activities, including setting-up the oven, drying and taking the wood into storage after drying, and that each of these activities take an equal amount of time, so the average cost of each sub-activity is 2,548 Baht per month. Depreciation for the pallets amounts to 150 Baht, for the tents is 180 Baht, and for the plastic sheet covers is 570 Baht per month. This gives a total monthly cost for this activity of 3,448 Baht.

5. Transferring the wood (after drying) from the drying area to the store: The calculation process for this stage is the same as for taking wood from the warehouse to the oven, but with use of only one vehicle. As a result, the total cost for this activity is 7,820 Baht per month.

6. Storing wood in the warehouse: The labor cost for the one employee used during this stage is 7,644 Baht per month. Since this one employee handles three sub-activities; setting-up the oven, drying and storing the wood after drying, and because all these activities take a similar amount of time, so the average cost per sub-activity is 2,548 Baht. With the additional use of chemicals at 138.65 Baht per month, this gives a total monthly cost of 2,686.65 Baht.

The estimated costs of all the resources used in each of the sub-activities described above are summarized in Table 1.

Table 1 Labor, equipment, machinery and other equipment costs within the wood preparation activity center (unit: Baht/month)

No.	Sub-Activities	Labor costs	Overheads	Cost of all resources supplied
1	Transfer the wood from storage to the oven	7,644.00	352.00	7,996.00
2	Oven-dry the wood	2,548.00	21,666.67	24,214.67
3	Transfer the wood from the oven to the drying area	7,644.00	352.00	7,996.00
4	Dry the wood	2,548.00	900.00	3,448.00
5	Transfer the wood from the drying area to the store	7,644.00	176.00	7,820.00
6	Store the wood	2,548.00	138.65	2,686.65
Total		**30,576.00**	**23,585.32**	**54,161.32**

4.3 Estimated acceptable capacity (practical capacity)

The factory's working hours are Monday to Saturday, 8 a.m. to 5 p.m. The four employees work an average of eight hours a day, for 26 days a month. Deductions for breaks, training and maintenance up to 10% of these working hours, meaning employees have an acceptable capacity of 11,232 minutes each per month.

4.4 Calculation of the capacity cost rates

The capacity cost rate (Baht per minute) can be obtained using the following equation (1).

$$\text{Capacity cost rate} = \frac{\text{Cost of all resources supplied}}{\text{Practical capacity}} \qquad (1)$$

As an example for using this equation, for sub-activity collecting the wood from the warehouse and transferring it to the oven, the capacity cost rate is 7,996 Baht/11,232 minute, or 0.71 Baht per minute. Table 2 gives a summary of the capacity cost rate of each sub-activity within the wood preparation activity center.

4.5 Development of activity center time equation

TDABC time equation is able to incorporate all the time needed to undertake all sub-activities in each activity center within a single equation [5], and the mathematical model used to establish TDABC time equation is shown below [9]:

$$T_t = \beta_0 + \beta_i X_i \qquad (2)$$

where

T_t = the time needed to perform an activity (minute).

β_0 = the standard time to perform the basic activity (minute).

β_i = the estimated time to perform the incremental activity (minute).

X_i = the quantity of the incremental activity (time).

Table 2 Capacity cost rate of each sub-activity for the wood preparation activity center

No.	Sub-Activities	Cost of all resources supplied (฿/month) [1]	Practical capacity (min/month) [2]	Capacity cost rate (฿/min) [1]/[2]=[3]
1	Transfer wood from storage to the oven	7,996.00	11,232.00	0.71
2	Oven-dry the wood	24,214.67	11,232.00	2.16
3	Transfer the wood from the oven to the drying area	7,996.00	11,232.00	0.71
4	Dry the wood	3,448.00	10,080.00	0.34
5	Transfer the wood from the drying area to the store	7,820.00	11,232.00	0.70
6	Store the wood	2,686.65	3,744.00	0.72
Total		**54,161.32**	**58,752.00**	

4.6. Determination of the estimated time for each activity

A time equation is needed to be developed to calculate the estimated production time. The estimated time for each activity was determined based on the Motion and Time study principles. For example, the average time taken for the transfer of wood from the warehouse to the ovens was found to be 24.15 minutes per round. This figure was then multiplied by the relevant variables or cost-drivers to develop the time equation, as shown in Table 3. Each variable in the time equation is defined in Table 4.

Table 3 Time equations for sub-activities of the wood preparation activity center

No.	Sub-Activities	Time equations
1	Transfer wood from storage to the oven	$24.15X_1$
2	Oven-dry the wood	$10X_2+10{,}368X_3+10X_4+60X_5$
3	Transfer the wood from the oven to the drying area	$23.03X_6$
4	Dry the wood	$10{,}080X_7$
5	Transfer the wood from the drying area to the store	$22.25X_8$
6	Store the wood	$0.57X_9$

From Table 3, the time equation for the wood preparation activity center was developed as shown in Equation (3)

$$T_{\text{wood preparation activity center}} = 24.15X_1 + 10X_2 + 10{,}368X_3 + 10X_4 + 60X_5 + 23.03X_6 + 10{,}080X_7 + 22.25X_8 + 0.57X_9 \quad (3)$$

4.7 Estimated capacity required by each activity center

The estimated capacity required by each activity was determined by quantifying the frequency of the activity in a month. By multiplying the amount of a given activity by the time spent doing it, one could calculate the total time spent on the activity. The volumes of cost-drivers for the wood preparation activity center are summarized in Table 4.

Table 4 Volume of cost-drivers for the wood preparation activity center (unit: Quantity/month)

Var.	Driver	Quantity/month
X_1	Transfer wood from storage to the oven (rounds)	200
X_2	Number of ovens operating (frequency/month)	2
X_3	Oven-dry the wood (frequency/month)	1
X_4	Number of ovens not operating (frequency/month)	2
X_5	Waiting periods (frequency/month)	1
X_6	Transfer the wood from the oven to the drying area (rounds)	160
X_7	Dry the wood (frequency/month)	1
X_8	Transfer the wood from the drying area to the store (rounds)	160
X_9	Store the wood (amount of wood)	4,000

The actual time spent on this activity center per month was determined by substituting the volume of cost-drivers from Table 4 into Equation (3), as shown below.

$$\begin{aligned}\text{The actual time spent} &= (24.15\times200) + (10\times2) + (10{,}368\times1) + (10\times2) + (60\times1) + (23.03\times160) + (10{,}080\times1) + (22.25\times160) + (0.57\times4{,}000)\\ &= 34{,}902.80 \text{ minutes.}\end{aligned}$$

The total time for the transfer of wood from the warehouse to the oven in one month can be represented by X_1 equals 200 in $24.15X_1$, so that $24.15\times200 = 4{,}830$ minutes. When multiplied by the capacity cost of 0.71 Baht per minute, it can be determined that the total production cost of this activity comes out as 3,429.30 Baht per month. Based on the same approach, the total production costs for each of the wood preparation sub-activities are shown in Table 5. This shows that the total production cost for the wood preparation activity center is 36,217.19 Baht per month.

Table 5 Elapsed times and total production costs for the wood preparation sub-activities

No.	Sub-Activities	Used time (min)	Capacity cost rate (฿/min)	Total cost (฿/month)
1	Transfer of wood from storage to the oven	4,830.00	0.71	3,429.30
2	Oven-dry the wood	10,468.00	2.16	22,610.88
3	Transfer the wood from the oven to the drying area	3,684.80	0.71	2,616.21
4	Dry the wood	10,080.00	0.34	3,427.20
5	Transfer the wood from the drying area to the store	3,560.00	0.70	2,492.00
6	Store the wood	2,280.00	0.72	1,641.60
Total		**34,902.80**		**36,217.19**

Calculated in the same way, the total production cost for the wood processing activity center is 89,313.87 Baht, and the total production cost for the retail packaging and delivery activity center is 164,457.21 Baht.

After the time equations for the wood processing activity center and the retail packaging and delivery activity center were created. The time equation to calculate the total time spent in the production of the draughts product is presented in Equation (4), as shown below.

$$\begin{aligned} T_{\text{production of Draughts}} = {} & 24.15X_1 + 10X_2 + 10{,}368X_3 \\ & + 10X_4 + 60X_5 + 23.03X_6 + 10{,}080X_7 \\ & + 22.25X_8 + 0.57X_9 + X_{10} + 0.3X_{11} \\ & + 1.14X_{12} + 0.45X_{13} + 2.05X_{14} + 0.34X_{15} \\ & + 0.48X_{16} + X_{17} + 1.01X_{18} + 0.53X_{19} \\ & + 0.38X_{20} + 2.03X_{21} + 1.57X_{22} + 0.58X_{23} \\ & + 1.48X_{24} + 2.54X_{25} + 1X_{26} + 1.22X_{27} \\ & + 0.1X_{28} + 0.2X_{29} + 1.03X_{30} + 4.42X_{31} \\ & + 4.05X_{32} \end{aligned} \quad (4)$$

4.8 Calculation of cost per product unit (unit cost)

The total cost of production can be obtained from the equation below:

$$\begin{aligned} \text{Total cost of production} = {} & \text{cost of direct materials} \\ & + \text{cost of direct labor} \\ & + \text{cost of manufacturing overheads} \end{aligned} \quad (5)$$

This process is explored in more detail below.

4.8.1 Cost of direct materials

A rain tree of 7,500 cubic centimeters costs 115 Baht a piece. A set of draughts pieces requires the use of 27.65 cubic centimeters of wood, the wooden board uses 202.80 cubic centimeters, and the wooden cover requires 196.75 cubic centimeters. So, one complete draughts set uses a total of 427.20 cubic centimeters of wood, meaning the cost is (115/7,500) × 427.20 = 6.55 Baht per unit.

4.8.2 Cost of direct labor and manufacturing overheads

The direct labor and manufacturing overhead costs incurred for producing a draughts set, using the TDABC method to calculate for each activity center, are as follows:

1. Since the wood preparation activity could not be allocated directly to each product because it is batch produced, the total production cost had to be allocated across all products at an equal rate. The number of all products manufactured in November 2014 was 12,000, and the total production costs of the wood preparation activity center were 36,217.19, leading to a figure of 36,217.19/12,000, or 3.02 Baht per unit.
2. As with the wood processing activity center, the packaging and delivery activity center costs were divided by the number of draughts sets produced. The total number of draughts sets produced in November 2014 was 4,000. The total cost of the wood processing activity center and the packaging and delivery activity center costs was 89,313.87 + 164,457.21, or 253,771.08 Baht. The unit cost for these two activity centers, was 253,771.08/4,000, or 63.44 Baht per unit.

Thus, the direct unit labor costs and manufacturing overheads for producing draughts sets is 3.02 + 63.44 = 66.46 Baht per unit.

4.8.3 Manufacturing cost per unit

Further to sections 4.8.1 and 4.8.2, we can conclude that the draughts production costs per unit (or set) is equal to 6.55 + 66.46, or 73.01 Baht per unit.

4.8.4 Product unit cost

The sales costs account for 10% of production costs, or equivalent to 7.30 Baht. Thus, the unit cost of each draughts set is 73.01 + 7.30, or 80.31 Baht.

The current price charged by the company for a draughts set is 85 Baht. Thus, the company's earnings per draught set are a mere 4.69 Baht.

5 CONCLUSION AND DISCUSSION

From the above data, it can be seen that the profit earned by the study company from selling draughts sets is very small; at just 4.69 Baht per unit. This figure is so low that the company is highly vulnerable to changes in the costs of resources or production factors such as labor and raw materials. By raising the sales price, the company's immediate problem may be solved, but this raises the risk of losing customers and lowering the company's ability to compete. As a result, the researchers have proposed ways to reduce production costs based on the analysis of capacity utilization; in order to increase production capacity and decrease unit costs. An example of how this might be done for the wood preparation activity center is described in Table 6.

Table 6 Analysis of capacity utilization in the wood preparation activity center

No.	Sub-Activities	Practical capacity (min/month) [1]	Used time (min) [2]	Un-used capacity (min) [3]=[1]-[2]	Capacity cost rate (฿/min) [4]	Loss of manufacturing costs (฿) [3]×[4]
1	Transfer of wood from storage to the oven	11,232.00	4,830.00	6,402.00	0.71	4,545.42
2	Oven-dry the wood	11,232.00	10,468.00	764.00	2.16	1,650.24
3	Transfer the wood from the oven to the drying area	11,232.00	3,684.80	7,547.20	0.71	5,358.51
4	Dry the wood	10,080.00	10,080.00	0.00	0.34	0.00
5	Transfer the wood from the drying area to the store	11,232.00	3,560.00	7,672.00	0.70	5,370.40
6	Store the wood	3,744.00	2,280.00	1,464.00	0.72	1,054.08
	Total	**58,752.00**	**34,902.80**	**23,849.20**		**17,978.65**

Having analyzed the production cost using TDABC, we have been able to identify un-used capacity; which results in waste costs, as summarized in Table 6. Table 6 shows that within the wood preparation activity center, the sub-activity ‘transferring the wood from the drying area to the store’ incurs a lot of waste, at 5,370.40 Baht. This is followed by the transfer of wood from the oven to the drying area stage, with a waste level of 5,358.51 Baht and then the transfer of wood from storage to the oven process, which incurs 4,545.42 Baht of waste. Among these three sub-activities, it was found that all the wasted costs are related to transportation. This one wood collector should be deployed on another activity, one that does not have sufficient work capacity, as this will help reduce the amount of un-used capacity.

The researchers discovered that using TDABC to identify production costs was consistent with the actual use of resources at the study company. It was found that the cost of each product is different due to the varying factors affecting the costs of producing them. Complex products take longer time to produce, and those that involve a lot of process steps tend to be high cost.

The results of this study have given the case study company a clear view on what their appropriate selling prices should be, and have also identified those processes that take a particularly long time. The study has also shown that the company can improve the process in order to reduce costs. The analysis has highlighted which activities add value and which activities are wasteful, as well as the difficulties to be found in the manufacturing process. By improving efficiency, resource waste can be reduced, particularly by optimizing production and reducing the number of work steps. This will lead to lower costs and improve productivity, as the product costs should arise only from value added activities.

ACKNOWLEDGEMENTS

This research was supported by Ball Ball Game Manufacturing Co., Ltd. The researchers would like to thank the company's employees, especially Mr. Kaneth Suwanleela (Manager) for giving the researchers access to the manufacturing information and for his support during the research. The researchers are also grateful for the financial support provided by the Research and Researcher for Industry (RRi) fund 2014, a part of the Thailand Research Fund (TRF).

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