International Organization of Research & Development (IORD)
ISSN: 2348-0831
Vol 10 Issue 01 | 2022

Activity based cost estimation for the fuel tank of a rigid inflatable boat

Vamanrao U. Rane [1], Dr. Vinay A. Shirodkar [2]
[1] M.E. (Industrial Engineering) student, Mechanical Engineering Department, Goa College of Engineering (Goa University,) Goa, India
[2] Professor, Mechanical Engineering Department, Goa College of Engineering (Goa University), Goa, India

DOI: 10.5281/zenodo.7162655

ABSTRACT

Activity-based costing, often known as ABC, is one of the well established techniques, that is used in the cost estimation of a product. In the competitive market environment, companies often resort to the ABC estimation technique to arrive at a precise estimate of their input costs, so that they can adopt an appropriate pricing strategy in the market. The cost estimation of a new product requires precise design and development cost estimate in addition to the manufacturing and overhead costs. In this paper, the ABC approach is used to arrive at a precise estimate for the newly design fuel tank of a rigid inflatable boat (RIB). The paper presents the well-defined methodology of ABC approach through proper identification and analysis of activities along with their drivers, cost centers and other relevant details in arriving at the precise cost estimate of the fuel tank.

Keyword: ***- Activity based costing, Activity driver, Cost centre, Activity driver cost, New product development.***

1. INTRODUCTION

Manufacturing companies are experiencing significant difficulties and challenges on account of multi objective goals in delivering high quality products while maintaining low pricing strategy. Moreover, the timing of the product entry into the market, particularly the newer variety, is as important as the product pricing. Accurate input costs estimation of products and processes in the manufacturing companies plays a crucial role in arriving at the profitable price of the end products, in this intensely competitive world.

Concurrent engineering, design for manufacturing ability and assembly, and sustainability are some of the factors that are forcing the companies to expand their operations beyond traditional manufacturing practices. Manufacturing companies must focus on boarder life cycle perspectives in product development. In this competitive and ever-changing market scenario, product life cycle is shrinking and hence design and development activity has gained tremendous importance. It means that companies should not only focus on the cost of production but also pay attention to design stage of a product's life cycle if they want to control the cost over the entire product life cycle.

In traditional costing, cost of the product is calculated by conventional overhead allocation methods that considers direct resources used. In activity-based costing, the cost is calculated through the detailed analysis of activities involved, to arrive at a more precise and traceable costing. As this method is based on the analysis of activities, it allows us to eliminate or reduce non value –adding activities to an extent possible while focusing on promoting and refining value-added activities [1].

For new product development, design and development activities play a very crucial role in addition to manufacturing activities. In this paper ABC approach is used in cost estimation of a newly designed 220 litres stainless steel fuel tank for a RIB through a systematic analysis of activities, driver, cost centers and cost center rates. The rest of paper is organized as follows. Literature review is covered in section 2. Section 3 highlights methodology of ABC approach. Implementation of the ABC approach in estimating the cost of newly designed fuel tank is discussed in section 4. Section 5 presents the conclusions.

2. LITERATURE REVIEW AND BACKGROUND

Researchers have focused on estimating the cost of product at an early stage by using different types of methodology and approaches. Some of these methods are entirely based on intuitive techniques, analogical techniques, analytical techniques, or a combination of these techniques. Cooper and Kaplan [2] have introduced ABC approach which gained wide popularity in the manufacturing industry as it provides consistent and reasonably accurate manufacturing costs [3].

In the ABC approach, product cost includes the cost of material & cost of valuable activities performed during the manufacturing process. Luong and Spedding [4] explored the concept of an analytical knowledge-based system for process plans and cost estimation for hole making. Takakuwa [5] created a framework to design simulation models so that flexible manufacturing systems could perform activity-based costing prior to engaging in actual manufacturing activities.

Ozbayrak at el. [6] implemented the ABC approach in an advance manufacturing system that runs under either material requirement planning or a just-in-time system." The traditional accounting system traces only the direct material and labour cost of the product. Johnson and Kaplan [7] detailed the shortcomings and effects of the traditional accounting system. Mohammad and Abbas [8] used ABC for casting in a steel foundry. They developed a relationship model that mathematically describes the cost of final casting as the function of all the consumable resources. Effective implementation of ABC helps in gaining competitive advantages and higher levels of productivity performance for manufacturing companies [9]. The major benefit of ABC is that it enhances the accuracy and relevance of the product costing by offering well-timed cost data appropriate for decision-making.

3. METHODOLOGY OF ABC APPROACH

Methodology of ABC approach for cost estimation is shown in fig. 1.

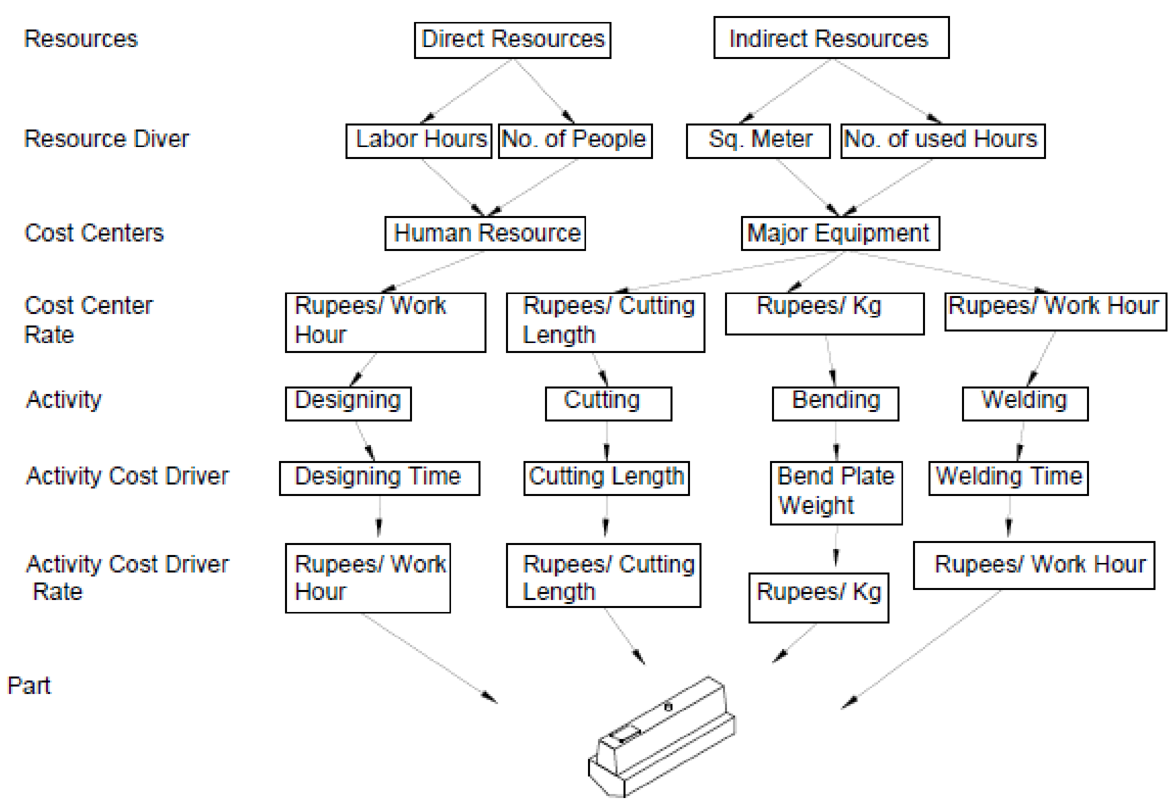

Fig-1: ABC Methodology: Shows the flow from resources to activity.

The steps involved in the ABC approach are as follows:

3.1 Cost centre identification.

Cost centres are the resources that are involved in manufacturing the product. Cost centres are categorized by machine equipment and human resources. Machine equipment includes machines used in the manufacturing process such as cutting machines, welding machines, bending machines etc. while the human resources include man hours of personnel like design engineer, project engineer, production engineer and so on.

3.2 Examine indirect cost and its cost driver rate.

Indirect costs are also known as overhead cost, which need to be assigned to the manufactured product. These costs encompass computer costs, electricity costs, printers, paper, maintenance costs, etc. Further in this step cost drivers for indirect resources are identified. For example, computer cost is assigned by the number of user hours while the building cost is considered in square meters.

The indirect resources cost rate is calculated from equation 1,

$$\text{Resorces Rate(RR)} = \frac{\text{Total cost for 1 year}}{\text{Resource driver spent in 1 year (RD)}} \quad (1)$$

3.3 Determine cost centre driver rate by assigning resources to each cost center.

This step involves allocating resources to cost centres based on the resource cost driver. Further total cost of each cost centre is determined. Then, one cost driver is identified for each cost centre.

The annual cost of the cost centre is calculated using equation 2,

$$\text{The annual cost for cost center} = \sum_{i=1}^{\text{no. of resources}} \begin{matrix}\text{Resource rate} \\ \text{X} \\ \text{Resource driver}\end{matrix} \quad (2)$$

The cost centre rate is given by equation 3,

$$\text{Cost center rate} = \frac{\text{Annual cost of cost center}}{\text{Cost center driver spent in 1 year (CCD)}} \quad (3)$$

3.4 Identify the Activity.

Activities involved in the product development process are identified. For the part under consideration, major activities include designing the part, material cutting, welding process, and so on. The activities are modeled using Integrated Definition (IDEF).

3.5 Analyze each activity and calculate the cost of each activity.

Each activity cost is calculated based on the resources assigned to cost centre. Multiplying the cost centre driver rates with the drivers consumed by each activity gives the total cost of the activity.

3.6 Allocate cost driver to each activity and determine cost driver rate.

The cost of activity is explained by a factor called activity cost driver. Various cost drivers are used in the ABC approach like transaction drivers that represents the frequency activity and the duration drivers that represent the amount of time an activity consumes. Few cost drivers are easy to track, such as cutting length which represents cutting operation, while other drivers require more details.

The activity cost driver rate is calculated using equation 4,

$$\text{Activity cost driver rate} = \frac{\text{Cost of activity}}{\text{Activity cost driver spent}} \quad (4)$$

3.7 Cost of the part is estimated by activity cost driver spent.

Equation 5, gives the cost of the product is estimated by the amount of driver spent and its cost driver rate.

$$\text{Cost of the one part} = \sum_{i=1}^{\text{no. of activity}} \begin{array}{c}\text{Activity cost driver} \\ \text{X} \\ \text{Activty cost driver rate}\end{array} \qquad (5)$$

Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work

4. IMPLEMENTATION OF ABC APPROACH

The ABC approach is implemented to analyze the cost incurred in manufacturing of 220 litre stainless steel fuel tank for RIB in boat manufacturing company. The fuel tank is shown in fig. 2.

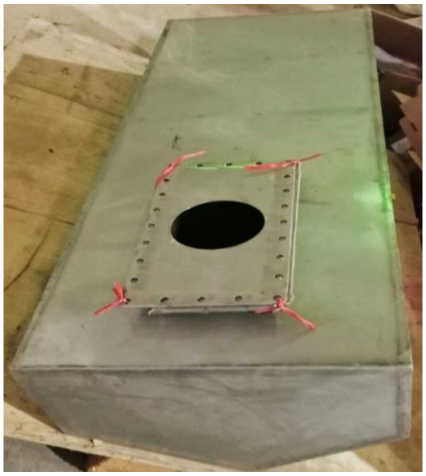

Fig-2: Picture of Manufactured Fuel tank.

4.1 Cost associated with indirect resources and its driver.

The expenses on the shop floor are the cost of manpower, raw material, equipment which appears in account ledger. All the resources and their drivers used on the shop floor for the manufacture of the fuel tank are listed in the table 1.

Table-1: Resources & its Cost driver on shop floor

Resources	Cost driver
Design Engineer	Labour Hours
Purchase Officer	Labour Hours
Production Engineer	Labour Hours
Operator	Labour Hours
Helper	Labour Hours
Building cost	Square meter
Computer Cost	No of People
Maintenance cost	Direct Cost

4.2 Design & development cost center.

In design & development phase, activities performed are categorized into various cost centres like design workstation, cutting machine, bending machine & welding machines.

Annual depreciation value of the machines is given by equation 6,

$$\text{Annual depreciation cost} = \frac{((\text{Pi } (1 + \text{i})\text{n})}{((1 + \text{i})\text{n} - 1))} \quad (6)$$

Where,

P is cost of the machine
i is the rate of interest
n is life span of machine (Assumed i = 10% and n = 8)

4.2.1 Assigning cost centre rates.

Annual cost of center cost is sum of all the expenses spent by individual cost center. All these expenses are gathered from previous records of traditional method. The cost driver related to cutting machine is allocated by cutting length in meter. Cost driver for the bending machine is the weight of the material in Kg. The cost center, their cost drivers and cost driver rate are listed in table 2.

10

Table-2: Cost centre, cost driver & driver rate

Cost center	Resource cost driver	Rate (₹/ Unit)
Design Engineer	Labour hours	142
Purchase Officer	Labour hours	117
Production Engineer	Labour hours	104
Welder	Labour hours	92
Helper	Labour hours	50
Bending Machine	Per kg	12
Cutting Machine	Cutting length	150
Welding Machine	Working hours	38

4.3 Identify activity involved in the development process.

All the activities involved in manufacturing of fuel tank are modeled using IDEF diagram and are listed in table 3. Appendix-I, covers the respective IDEF diagram.

The process starts with raising of work order. Then project planning is done by design engineer and it is discussed with the team. Design engineer, production engineer & purchase officer are the cost centres involved in this activity. The design engineer designs the product considering resources available on the shop floor. Once the design is ready, manufacturing drawings and bill of material are prepared and shared with production engineer and purchase officer for further action. Purchase officer places the order for material as per the specification. After the receipt of material, quality engineer does the inspection & once the material clears the quality check, it is sent for cutting & bending process. After completion of this process, material is sent to weld shop where welding activity is carried out. Before starting welding, setting up of material is done as per drawing by tag weld and dimensions are measured. If the dimensions measured found within limit, then welding is done for complete part followed by cleaning & deburring activity. At the end, the tank dry survey is carried out & tested to hydrostatic pressure head 1.5 meter above tank top.

Table-3: Activities involved in manufacturing of fuel tank

Activity	Activity Driver	Cost Centers
Design Part	Hours	Design Engineer
Discuss Product	Hours	Design Engineer, Production Engineer, Purchase officer
Purchase of material	Number of Orders	Purchase officer & Material cost
Cutting of Material	Cutting length	Technician, Cutting Machine
Bending of Material	Per Kg	Technician, Bending Machine
Material Setup	Hours	Welder & Helper
Welding	Hours	Welder, Helper & Welding machine
Debur & Cleaning	Hours	Welder & Helper
Inspection & Testing	Hours	Design Engineer, Production Engineer & Helper

4.4 Result

The calculated cost of various activities, driver and driver rate consumed by the product is presented in table 4.

Table-4: Activity cost driver rate

Activity for Part	Total cost for Part	Activity Driver	Activity driver Spent	Activity driver Rate
Design Preparation	355	Design Hours	2.5	142
Discuss Product	182	Discuss Hours	0.5	363
Purchase Material	18500	Number of Orders	1	18500
Cutting of Material	1650	Cutting length	11	150
Bending of Material	1296	Per kg	108	12
Material setup	284	Hours	2	142
Welding	1080	Hours	6	180
Debur & Cleaning	71	Hours	0.5	142
Testing	296	Hours	1	296
Total cost of Part	23714			

Total cost of manufacturing of the fuel tank is ₹ 23714. The existing cost of the same tank that is calculated generally using traditional volume-based costing (VBC) is ₹ 29880. We observe that there is approximately 26 % reduction in the cost estimate of the fuel tank as calculated using ABC over VBC.

5. CONCLUSION

In this paper, the ABC approach is applied to estimate the cost of the newly manufactured fuel tank for RIB. As per previous research studies, the ABC approach is found to be more precise than the traditional costing method. In this study, we employ the ABC approach to estimate the cost of manufacturing of the fuel tank, starting from the new product development phase. Under this approach, the cost of the product is calculated by analyzing each activity that is performed starting from the product development phase. Direct and indirect costs are assigned to the cost centres that serve these activities. The product's cost is determined by the activity cost driver that the product consumes. The newly estimated cost is inclusive of design and overhead costs, as these overhead costs are systematically assigned to the product to get precise product cost. Here we observed that estimated cost of the fuel tank by ABC approach is approximately 26% less than the cost obtained using traditional methods.

It is worth noting that the cost incurred in design and development, being onetime cost, is only 2.6% of the total cost. The long-term material and manufacturing costs will still be lesser than the current estimate obtained using ABC.

The ABC approach is proven to be more accurate and has a precise cost estimate than the traditional cost estimation method. This helps the decision makers to be more competitive in the market while still being profitable. The success of the ABC approach is mainly due to logical and detailed analysis of each activity, which facilitates promoting only value adding activities and reducing all non-value adding activities. An apparent extension would be to use feature-based cost estimation along with ABC approach.

6. APPENDIX-I

The activities involved in manufacturing of tank are modeled using IDEF diagram. Fig 3-5 represents respective IDEF diagrams.

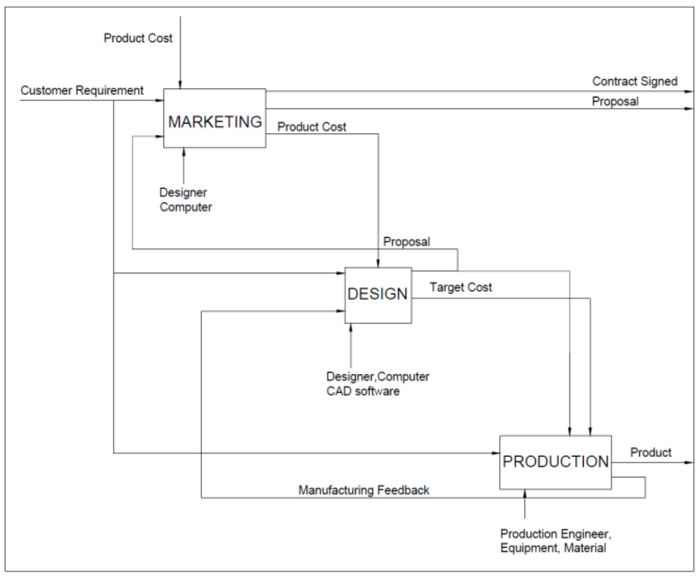

Fig-3: Initial product development process

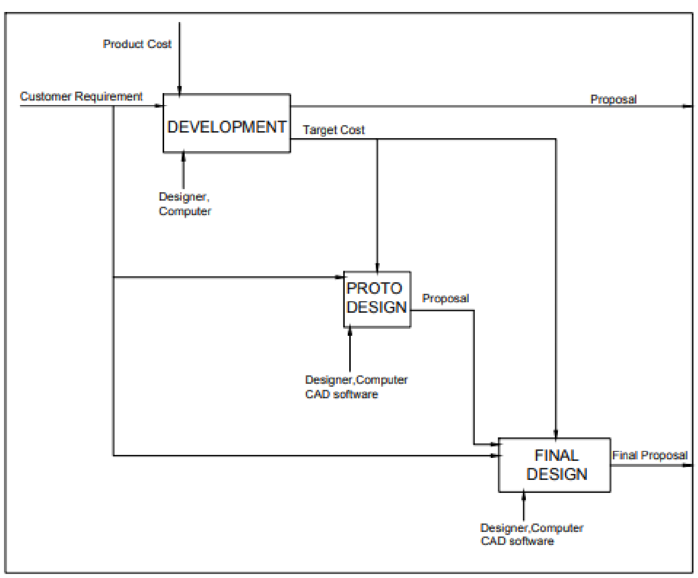

Fig-4: Designing activity

 DOI: 10.5281/zenodo.7162655

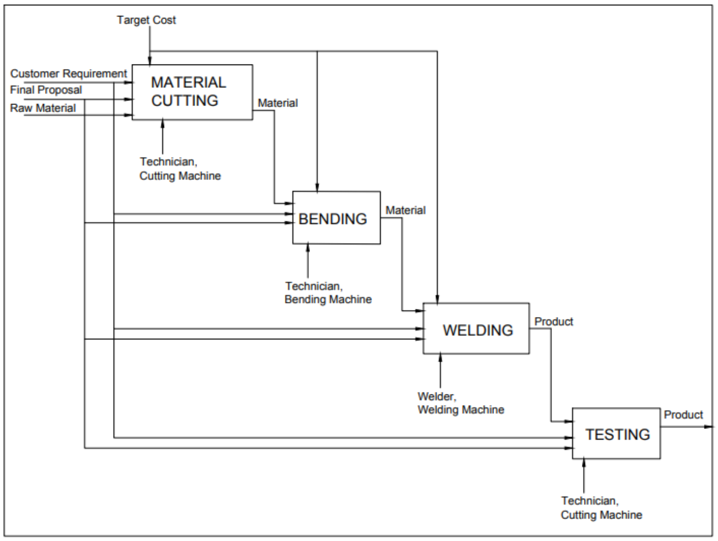

Fig-5: The manufacturing activity

7. REFERENCES

[1] K. Gunasekaran, and M. Sarhadi, "Implementation of activity-based costing in manufacturing," International Journal of Production Economics, 5(6):231-242, 2008.
[2] R. Cooper, and R. S. Kaplan, "How cost accounting distort product cost," American Journal of Industrial and Business Management Vol. 2, 20-27, 1988.
[3] M.C. Andrea, R.C.P. Filho, A.M. Espozel, L.O.A. Maia, and R.Y Quassaim, "Activity-based costing for production learning," International Journal of production Economics 62, 175-180, 1999.
[4] L.H.S. Luong, and T. Spedding, "An integrated system for process planning and cost estimation in hole making," International Journal of Advance Manufacturing Technology 10, 411-415, 1995.
[5] S. Takakuwa, "The use of simulation in activity-based costing for flexible manufacturing systems," Proceedings of the 1997 Winter Simulation Conference, Atlanta, GA, USA. Pp. 793-800, 1997.
[6] M. Ozbayrak, M. Akgun, and A.K. Turker, "Activity-based cost estimation in a push/pull advance manufacturing system," International Journal of production Economics. 87:49-65, 2003.
[7] H.T. Johnson, and R.S. Kaplan, "Relevance lost: The rise and fall of management accounting," MA: Harvard Business School Press, 2007.
[8] D. Mohammad, and A.R. Abbas, "Activity-based cost estimation model for foundry systems producing steel castings," Jordan Journal of Mechanical and Industrial Engineering. Vol 6: 75-86, 2012.
[9] S.A. Effiong, and A.E. Ekpan, "Effect of activity based costing (ABC) on the productivity of manufacturing company," International Journal of Advance Research. 7(1), 753-765, 2019.