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The Activity-based Costing Approach for Estimation of Part's Cost in FMS with A(2)-Degree Automation: A Case Study in a Forging Industry

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Abstract: ABC has become mature cost estimation and accounting strategies. Using ABC for cost estimation of manufactured parts is being practiced today with acceptable rate of success. The objective of this study is to present strategies to evaluate the cost in Flexible Manufacturing System (FMS) with A(2)-degree automation for produced parts. For this goals, by using Activity-based Costing (ABC), first find the requirement resources and activities of parts and then, evaluated the cost of the uses the especially formulas. With implementation of ABC and using accounting formulas, the cost of a part equals the cost of raw materials plus the sum of the costs of all activities used to produce the part. Finally, comparison and analysis between ABC and Traditional Cost (TC) are presented in this research.

Key words: Activity-based costing, flexible manufacturing system, actual cost, A(2)-degree automation, traditional cost, especially cost calculator formulas, forging

INTRODUCTION

Traditional cost systems are known to distort the cost information by using traditional overhead allocation methods (that rely on direct resources such as labour hours). Activity-based Costing (ABC), on the other hand, has gained the recognition of a more accurate cost estimation and calculation method (Ben-Arieh and Qian, 2003).

Activity-based costing was introduced by Kaplan and Cooper (1988a, b) as an alternative to traditional accounting techniques. Since then, it has been increasingly used in multi-level, complex manufacturing organizations. ABC is a procedure that often makes it possible to estimate product costs more accurately than traditional cost systems. Research on the determinants of ABC system implementation effectiveness has identified contextual and implementation process factors that correlate with evaluations of the ABC system. These studies define factors that relate the ABC implementation initiative to the broader organization. For example, Foster and Swenson (1997) and Shields (1995) examine whether the initiative is perceived to have top management support and whether users believe there are benefits associated with adopting ABC. ABC is often used as a part of total cost management. ABC system differs from traditional system in two ways: first, cost pools are defined as activities rather than production cost centers and secondly, the cost drivers used to assign activity costs are structurally different from those used in traditional cost systems. The purpose of an ABC system is to focus on the cause behind indirect costs. Activities, rather than traditional departments, are emphasized in order to isolate the cost drivers or factors most likely to cause or contribute to the in occurrence of costs (Lewis, 1995).

ABC has been applied to various industries (Tsai, 1996) such as electronics (Merz and Hardy, 1993), automotive (Miller, 1994), aerospace and defense (Soloway, 1993), airplane manufacturing (Haedicke and Feil, 1991), shipbuilding (Porter and Kehoe, 1994) and telecommunication (Hodby *et al*., 1994), among many other areas of application. Sriram (1995) studied how flexible manufacturing systems affect the accounting information system of an organization switching to FMS.

The objective of this research is to present strategies to evaluate the cost in FMS with A(2)-degree automation for produced parts. For this goals, by using ABC, first find the requirement resources and activities of parts and then, evaluated the cost of the uses the especially formulas. With implementation of ABC and using accounting formulas, the cost of a part equals the cost of raw materials plus the sum of the costs of all activities used to produce the part. This model has been applied in a forging industry. Finally, comparison and analysis between ABC and TC are also presented.

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CASE STUDY

Iran Tractor Forging Co. produces high quality forgings, primarily for the customer oriented automotive and industrial market. Forging lines from 2 to 80 MN give us capability for forging from a few hundred grams up to about 100.

The case study selected in this research involves a forging plant that Based on G. Amber and P. Amber laws (Automation criteria) has A(2)-degree automation. The main objective of this case study is to demonstrate the method of designing an ABC system in a flexible manufacturing system with especially automation degrees and the implications of ABC on the operations control and the determination of the actual cost of parts. The plant produces different parts in every month with especially operational plan per parts. The activities performed during the production can be divided into the following operations:

Cutting, heating then rolling, forming, trimming, inspection and experiment, heat treatment, shot blasting and end-control.

Some of the operations such as rolling (that has 0, 1, 2, 3 or 4 step based on the operational plan and type part), forming (that has 1, 2 or 3 step based on the operational plan and type part) and trimming (that has piercing, clipping or hot setting step based on the operational plan and type part) are more important.

IMPLEMENTATION OF ABC IN ACTUAL SYSTEM

As a starting point, we show the ABC cost model in Table 1. Twelve resources are considered: direct labor, production line, cutting, heat treatment, shot blasting, raw material, maintenance, control and inspection, setup, energy, vehicles and others. As a resource, direct labor or production line is consumed by the activity of processing (cutting, rolling, pressing, heat treatment and shot blasting). Maintenance, control and inspection, setup, energy, vehicles and others are a resources are consumed by the activity of preventive/repair (p/r) maintenance, supervising (quality control), tolling and fixture, utility, material handling and line stop of the products, respectively. Raw material resource is consumed by the activity of processing.

The activity-product cost drivers are also shown in Table 1. The procedures used in calculating costs by TC and by ABC are given in Table 2. In TC, indirect costs are calculated by using a coefficient factor multiplier and direct costs. Using ABC, indirect costs are calculated directly as the sum of p/r maintenance, supervising labour, tolling and fixture and utility costs, production line time costs and material handling costs. Based on data in the Table 1 and 2 the cost data for resources are shown in Table 3.

RESULTS AND DISCUSSION

Table 4 shows the demands of parts. Also, Table 5 shows the summery stop-watch studies such as processing time in production line and weight of parts before (initial weight)/(part weight) after production line

Table 1: ABC model

Resource	Activity	Cost driver
Direct labor	Processing	Processing time
Production line		
Cutting	Processing	Overhead and wage
Heat treatment		
Shot blasting		
Raw material	purchase	Initial weight of part
Maintenance	P/R maintenance	Time and part weight
Control and inspection	Quality control	Inspection time and part weight
Setup	Tolling and fixture	Part weight
Energy	Utility	Initial weight of part
Vehicles and indirect labor	Material handling	Weight of part
Others	Stop line	Part weight

Table 2: Formulas utilized to calculate costs of a part

Direct labour cost	C_{dl} = R_{dl}×Processing time
Raw material cost	C_{rm} = R_{rm}×Initial weight
Production line cost	C_{pl} = R_{pl}×Processing time
Energy cost	C_e = R_e×Initial weight
Cutting cost	C_c = $(1/R_c)$×60×(Overhead + wage)
Heat treatment cost	C_{ht} = $(1/R_{ht})$×60×(Overhead + wage)
Shot blasting cost	C_{sb} = $(1/R_{sb})$×60×(Overhead + wage)
Material handling cost	C_{mh} = 0.001×(R_{mh1}January 24, 2006×(Initial weight) + R_{mh2}×(Part weight))
Maintenance cost (in month that part is produce)	C_m = R_m×(Part weight)
Control and Inspection (in month that part is produce)	$C_{c\ and\ I}$ = $R_{e\ and\ I}$×(Part weight)
Setup cost (in month that part is produce)	C_s = R_s×(Part weight)
Others cost (in month that part is produce)	C_o = R_o×(Part weight)
Direct cost (DC)	= $C_{dl}+C_{rm}+C_c+C_{ht}+C_{sb}$+1150 (cost of mould per part)
Indirect cost for TC (IC)	= DC×coefficient
Indirect cost for ABC(IC)	= $C_{pl}+C_e+C_{mh}+C_m+C_{c\&I}+C_s+C_o$
Total cost for one part	= DC + IC

Table 3: Cost data for resources

Associated unit cost	Relevant unit	Value
Direct labour (R_{dl})	Rial/min	187.18
Raw material (R_{rm})	Rial/kg	6000
Production line (per part) (R_{pl})	Rial/min	5000
Energy (R_e)	Rial/kg	20.18
Cutting wage	Rial/min	8000
Cutting overhead	Rial/min	5000
Heat treatment wage (normalizing)	Rial/min	9000
Heat treatment overhead (normalizing)	Rial/min	6000
Heat treatment wage	Rial/min	1700
Heat treatment overhead	Rial/min	6000
Heat treatment wage	Rial/min	9000
Heat treatment overhead	Rial/min	6000
Shot blasting wage	Rial/min	1500
Shot blasting overhead	Rial/min	5700
Material handling before pressing (R_{mh1})	Rial/ton	546.62
Material handling after pressing (R_{mh2})	Rial/ton	737.57
Maintenance (R_m)	Rial/kg	15.06
Control and Inspection ($R_{c\ and i}$)	Rial/kg	55.51+11.32×(Part weight)
Setup (R_s)	Rial/kg	2.04
Mould	Per part	1150
Others (R_o)	Rial/kg	3.42

Table 4: Three months production demands

	1	2	3	4	5	6
Part name	TF0025	TF0051	TF0120	TF0138	TF0290	TF0291
Demand	8800	8800	7000	4500	2400	3790

operation for 6 parts that doing for requirement data in accounting formulas. Based on the calculation procedure presented in section 3, cost components are calculated by TC and using ABC in Table 6, 7 and 8, respectively.

In Table 6 and 8, total cost shown for comparison of Activity-Based Costing of Part with Traditional Costing of Part based on indirect cost. In the TC's estimations, we saw intense fluctuations of costs, but in the curve of ABC these fluctuations are moderate. These estimations show a Considerable difference between the ABC and TC estimates. The essence of TC lies in the concept that directs costs, direct labor and/or direct materials-constitute the basis for the allocation of indirect costs. Normally, the indirect cost is calculated by multiplying the direct cost by a coefficient constant. The value of this constant is based on experience. Before the advent of modern manufacturing technologies and the change from production-driven to market-driven economic environments, TC methods were adequate due to two reasons:

- The fraction of total product cost due to the direct cost component was substantially larger than the indirect cost component.
- The indirect cost component was-and is-inherently more expensive to determine than the direct cost component.

As a result, TC was considered satisfactory for general purposes.

Figure 1 and 2 show intensity dependence of direct and indirect costs (finally actual cost) to cost driver (For part sample: TF25). In Fig. 2 we consider intensity dependence of part cost to cost driver of line production activity (that this activity to be depended on operational plan and sequence of part). As well as, for other parts we have same bar cure, so TC can not estimated the actual cost of parts accurately.

According to above statement and with due attention to calculating of indirect costs in TC is possible that one activity to not be accomplished on part (or this activity to spend less operation time in individual operation), but the cost of this activity calculated for that part. In other words, the TC tends to underestimate the time it takes to

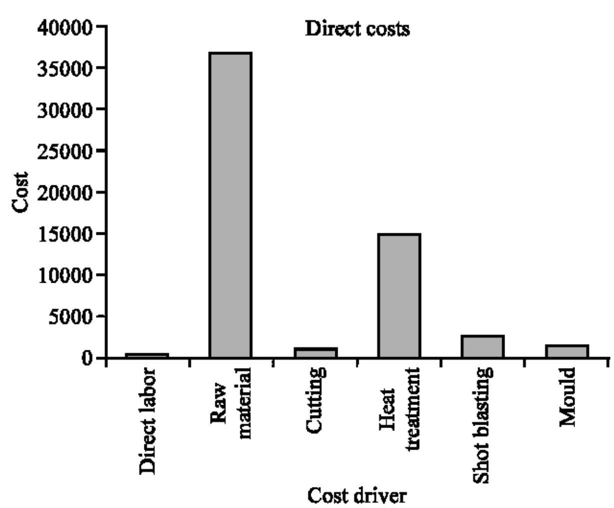

Fig. 1: Intensity dependence of direct costs (final actual cost) with cost driver (For part sample: TF25)

Table 5: Requirement data for computation

Part name	Processing time (Sec)	Initial weight	Part weight	Operation rate (part/h) cutting (R_c)	Heat treatment (R_{ht})	Shot blasting (R_{sb})
TF0025	175.75	6.41	5.17	840	60	180
TF0051	160.97	2.98	1.85	840	130	400
TF0120	144.69	4.11	2.9	840	60	300
TF0138	174.17	2.87	1.42	840	175	420
TF0290	164.89	5	4.45	840	175	310
TF0291	154.89	2.25	1.87	60	375	1500

Table 6: Computing total cost of parts with TC

Part name	Direct labor	Raw material	Cutting	Heat treatment	Shot blasting	Mould	Direct cost (DC)	Coefficient	Indirect cost (IC)	Total cost
TF0025	548.3	36758	928.57	15000	2400	1150	56784.87	0.4	22713.95	79498.82
TF0051	502.2	17135	928.57	6923.08	1080	1150	27718.85	0.4	11087.54	38806.39
TF0120	451.4	23632.5	928.57	7700	1440	1150	35302.47	0.4	14120.99	49423.46
TF0138	543.4	16502.5	928.57	5142.86	1028.57	1150	25295.90	0.4	10118.36	35414.26
TF0290	514.4	28750	928.57	5732.48	1393.55	1150	38469.00	0.4	15387.60	53856.60
TF0291	483.2	12937.5	13000	2400	288	1150	30258.70	0.4	12103.48	42362.18

Table 7: Computing indirect cost for ABC

Part name	Production line	Energy	Material handling	Maintenance	Control and Inspection	Setup	Others	Indirect cost (IC)
TF0025	14645.85	129.3	7.3	77.7	589.6	10.5	17.7	15477.95
TF0051	13414.15	60.1	3	27.7	141.4	3.8	6.3	13656.45
TF0120	12057.50	82.9	4.4	43.7	256.2	5.9	9.9	12460.50
TF0138	14514.15	57.9	2.6	21.4	113	2.9	6.8	14718.75
TF0290	13740.85	100.9	6	47	471.2	9.1	15.2	14390.25
TF0291	12907.50	45.4	2.6	28.2	143.3	3.8	6.4	13137.20

Table 8: Computing total cost of parts with ABC

Part name	Direct Cost (DC)	Indirect Cost (IC)	Total cost
TF0025	56784.87	15477.95	72262.82
TF0051	27718.85	13656.45	41375.30
TF0120	35302.47	12460.50	47762.97
TF0138	25295.90	14718.75	40014.65
TF0290	38469.00	14390.25	52859.25
TF0291	30258.70	13137.20	43395.90

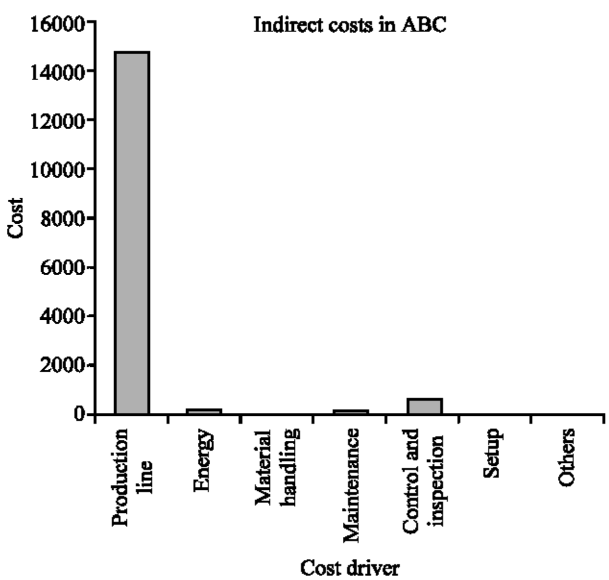

Fig. 2: Intensity dependence of indirect costs (final actual cost) with cost driver (For part sample: TF25)

make a prototype part and to adjust the manufacturing parameters (which is the major part of the cost). The discrepancy between the ABC and traditional cost estimates grows as the parts become more complex, which require more extensive development and experimentation with the manufacturing procedures.

CONCLUSIONS

Cost management has tended to view all costs not directly attributable to producing a given unit (chiefly labor and raw materials) as an overhead. The assumption is that these overheads are fixed. ABC challenges this assumption and more importantly, presents us with a method of calculating costs that vary with factors other than unit volume. Crucially, ABC represents a way of demonstrating what many managers have always suspected-that the amount of work (and potentially its cost) varies with overall levels of activity in the firm. When the firm is busy, everyone is busy-even those areas that we would expect not to vary with activity such as personnel management.

It is clear that ABC costing provides more accurate cost information than that of the traditional costing methods. So, we can use this information to initiate improvements. The costing at part level or sub-operation level helps the management to make a make or buys decision. The analysis of activities to identify activities and bench marking at each activity level direct improvement efforts in the right direction.

Therefore, forging plant should use ABC for all of their parts to calculate the cost of them and produce profitability accurately. The cost driver of each activity can be used to measure the performance of activities. The benefits to the manufacturing from using Activity-Based Costing include support for estimation of new parts, control of part manufacturing in term of cost and task accomplished and performance evaluation for the various activities.

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