The Activity Based Costing method opportunity to assess and master the aircraft maintenance service cost for Third Party: a case study

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Abstract

This work illustrates how to calculate accurate aircraft maintenance costs using Activity Based Costing (ABC). Comparing to traditional cost calculation, the proposed method is useful for aircrafts maintenance activity integrated to Airline Company and who wants to diversify its revenue by selling some available maintenance slots to third party clients for a competitive price. This paper takes base maintenance check process of a Moroccan airline aircrafts maintenance activity as a case study. The actual method used to calculate aircraft maintenance check cost can't not be applied to third party client pricing system. The ABC method shows substantial benefits if it is successfully implemented. Data collection through interviews and questionnaires are the main sources to this study.

Keywords: *Activity Based Costing, Aircraft Maintenance, Costs.*

Introduction

The global air traffic has undergone many changes in recent years. On the one hand, its development has been extremely rapid since it was multiplied by thirty in almost thirty years (82 million passengers in 1982 against nearly 2.7 billion in regular lines in 2011[1] .On the other hand, market liberalization, embedded in a context of economic globalization, increases in fuel prices as well as the ongoing global financial crisis that started in 2008 [2], has had an impact on airlines, with increased competition and a prices softening. With this increased competitiveness and war price, airlines are forced to reduce their costs, including maintenance cost .Typically it ranges from approximately 10 to 20 % of Airplane-Related Operating Costs (AROC) [3-5]. In this context, the compression of these costs is a priority for the survival of these companies.

For maintenance organizations, knowledge of aircraft maintenance cost is an essential information to the services pricing provided to airlines, which are increasingly demanding the maintenance of their fleets, to the best conditions of safety, quality and economy. However, most organizations are still using the same traditional cost accounting systems developed decades ago, while most financial departments (70%) recognize ABC [1] as a performance measure method. If this method is pragmatically developed and methodology implemented, it will provide quick and visible results, especially in crisis times[6].

The aim of this paper is to contribute to the design of a new model of cost calculation according to the ABC approach, dedicated primarily to aircrafts maintenance activity integrated to an Airline Company, through a case study conducted within a maintenance centre of a major Moroccan airline.

2. Activities Based Costing system interest

In the eighties in the U.S.A, an enthusiasm was growing for a new approach in cost accounting called Activity Based Costing method (ABC). Pioneered by Cooper, Kaplan and Johnson [7-14] and presented as a method adapted to the new economic environment. Its ambition is to provide a framework for overcoming the difficulties encountered in Traditional Cost Accounting (TCA). In today's globally competitive market, ABC is a powerful tool that provides reliable and accurate cost information. It enables manufacturing and services organizations to improve their competitiveness and make better decisions based on an improved understanding of their product cost behaviour.

The method intends to guide costs with maximum visibility and remove up all the elements that may give a distorted picture of resources consumption cost as commonly observed in TCA[15]. Traditional cost systems known to distort the cost information by using traditional overhead allocation methods .It involves collecting indirect costs from departments and then allocates them to products or services. In contrast, ABC collects indirect costs of activities and assigns activity costs to cost object

[1] Study conducted by IDC (International Data Corporation) in July 2006 after a series of 200 interviews.

[16]. The assignment of costs through ABC occurs in two stages: cost objects (i.e., products, services, customers) consume activities and activities consume resource costs [16,17]. This means, opposing the traditional view of expenses direction (**Fig.1**).

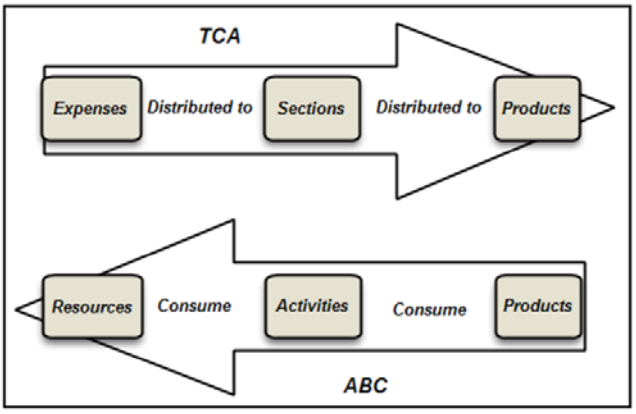

Fig. 1 Resource consumption ABC vs. TCA

In the first stage (**Fig.2)**, costs assigned to cost pools within an activity centre, based on a cost driver. There is no equivalent step in a traditional costing approach. In the second stage, costs allocated from the cost pools to cost objects based on these objects' consumption of the activities. This stage is similar to TCA except that the traditional approach uses a single volume-based cost driver to allocate overhead costs to cost objects without consider-ation for non-volume-related characteristics [18] . After seeing the activities costing system value, we will see in the next section, the actual method and its limits to calculate aircraft maintenance cost.

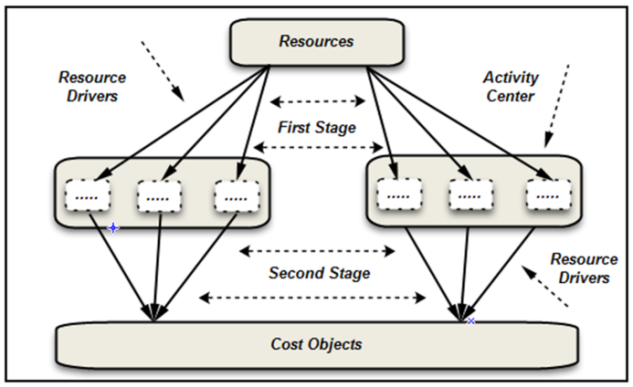

Fig. 2 Cost assignment procedure in ABC[16]

3. The Moroccan Airline Maintenance Centre

The Moroccan Airline Maintenance Centre (MAMC) is a technical department of a major Moroccan airline. Its main mission is to maintain the company's fleet in airworthiness state and provide, as possible, maintenance work to third parties. MAMC cost accounting practices performed according to the complete cost method, primary for annual budget determination. The allocating key used for overhead cost is ***Flight Time*** Company's airline fleet.

3.1 Analysis of the actual aircraft maintenance cost calculating

Through an example, we will illustrate the actual methodology used to calculate the aircraft maintenance.

Table 1: Aircrafts consumed charges

Costs types	*Annual Costs*	*Boeing 737-400*	*Boeing 737-700*	*Boeing 737-800*	*Total*
Direct Costs (KMAD)		**71800**	**48100**	**217900**	**337800**
	Base maintenance Consumable Material	3500	2000	10000	15500
	Heavy maintenance Consumable Material	40000	30000	100000	170000
	Engine maintenance	4000	3000	5500	12500
	Aircraft equipments maintenance package	4000	3000	2000	9000
	Direct labour	20000	10000	100000	130000
	Aeronautical material rent	300	100	400	800
Overhead Costs (KMAD)					**222000**
	Engineering and aircraft documentation				7000
	Indirect labour				60000
	Depreciation				80000
	General expenses				75000
Total Cost (KMAD)					**559800**

Assume that the company's fleet consists of three aircrafts types. These aircrafts receive distributed expenses (**Table 1**). Note that at this level the overhead costs are not distributed. After annual flight time accounting for each aircraft type is done, a distribution coefficient is determined and used as overhead costs allocation key among aircrafts types (**Table 2**). The overhead costs distribution is as follow (**Table 3**). All expenses are then, divided by the accumulated flying time to get the full cost per flight hour (**Table 4**).

Table 2: Allocation key

Aircraft Types	*Mean annual flight Hours (1)*	*Coefficient% (1)/(2)*
Boeing 737-400	30000	**20**
Boeing 737-700	50000	**33**
Boeing 737-800	70000	**47**
Total Annual Flight Hours (2)	**150000**	**100**

Table 3: Aircrafts consumed charges after allocation

Costs types	*Annual Costs*	*Boeing 737-400*	*Boeing 737-700*	*Boeing 737-800*	*Total*
Direct Costs (KMAD)		**71800**	**48100**	**217900**	**337800**
	Base maintenance Consumable Material	3500	2000	10000	15500
	Heavy maintenance Consumable Material	40000	30000	100000	170000
	Engine maintenance	4000	3000	5500	12500
	Aircraft equipments maintenance package	4000	3000	2000	9000
	Direct labour	20000	10000	100000	130000
	Aeronautical material rent	300	100	400	800
Overhead Costs (KMAD)		**44400**	**73992,6**	**103607,4**	**222000**
	Engineering and aircraft documentation	1400	2333,1	3266,9	7000
	Indirect labour	12000	19998	28002	60000
	Depreciation	16000	26664	37336	80000
	General expenses	15000	24997,5	35002,5	75000
Total Cost (KMAD)		**116200**	**122092,6**	**321507,4**	**559800**

Table 4: Cost per flight hour

Annual Costs	*Boeing 737-400*	*Boeing 737-700*	*Boeing 737-800*	*Total*
Direct Costs (KMAD)	71800	48100	217900	**337800**
Overhead Costs (KMAD)	44400	73992,6	103607,4	**222000**
Total Cost (KMAD)	116200	122092,6	321507,4	**559800**
Cost per Flight Hours (KMAD)	**3,87**	**2,44**	**4,59**	**10,91**

Thus, the Boeing 737-800 maintenance cost is 45 900 MAD per flight hour. So for a technical check type A that is done at 400 flight hours interval, it will cost using this method 45 900 x 400 = 18360000 MAD.

3.2 Limits

The cost system, pursued in (MAMC), is based on a narrow management control view. The primary responsibility is to prepare budgets and daily commitments monitoring to ensure that the (MAMC) complies with headquarter financial department given budget. The actual cost system established is based on existing tools to budget the most important positions. These tools come essentially from the general accounting, which is analytical monitoring of aircraft heavy maintenance. Regarding the aircraft base maintenance, the direct cost is determined by type of aircraft is based on the historical and technical support contracts, in order to have the budget for this activity. Therefore, the cost monitoring system is established primary to meet budgetary needs.

Thus, the missing of complete cost system per aircraft maintenance check makes it very difficult to assess, on one hand, the competitiveness of (MAMC) at two levels: The direct costs system through aircraft type does not allow having a benchmarking to study the possibility to outsource expensive maintenance work compared to industry costs. Also The (MAMC) is pursuing a development policy for maintenance work to third parties.

However, the current system does not determine the correct price to charge customers. On the other hand, the use of a single key (Flight Time) for overhead costs allocation without direct causal link with the real consumption of resources, induces a subsidizing effect of aircraft check costs between the different aircrafts types.

4. ABC implementation process

The implementation of ABC method implies to define the process of resources consumption. This will require the following steps [19]:

- Define cost object,
- Define activities that contribute to the achievement of these cost objects,
- Define drivers associated with each activity that measure resources consumption,
- Define relationship between cost object, activities and resources.

4.1 First Step: Define Cost Object

The (MAMC) maintains aircrafts and their equipments. Thus, there are two main processes: Aircraft maintenance and Equipment maintenance. The engineering and industrial logistics functions support these two main processes. Due to huge resources required for modelling all the centre's activities, we limited our focus to the process of aircraft maintenance. The importance of aircraft maintenance activity, which is the primary mission of this centre, motivated this choice.

The various services offered by the aircraft maintenance activity are:

- Aircrafts periodical technical checks (Pre-flight, daily, Weekly, A, C, and D checks).
- Service Bulletins (SB) and the Airworthiness Directive (AD) application for aircrafts;
- Aircrafts systems or structure modifications according to standards approved by the manufacturers and official services (DGAC, FAA, EASA)[1]
- Structural repairs in accordance with approved standards
- Aircrafts engines removal and installation.

Our study (cost object) will focus on ***the standard technical check (Type A)*** which forms the basis of aircraft maintenance. The engineering support intervention is, in general, at non-standard services (application of SB, AD...) therefore, it is excluded from our study field. After determining the cost object, comes the activities research that contribute to the achievement of the latter.

4.2 Second Step: Define the activities that contribute to the achievement of the cost object.

The different organization activities definition is an important step in the method. It is indeed, cutting the production organization to activities that will define the resources process consumption by services. Three steps can be set for the completion of a technical check (**Fig.3**):

- The technical check preparation;
- Work execution.
- Updating information system.

Once we well assimilated our study domain, we targeted personnel who were involved in aircraft maintenance process. We also, developed questionnaires in addition to what we collected through the procedures organizing the tasks and roles of each actor in the process. These data led to a list of activities called the initial list (Example **Table 5**).

[1] DGAC=Direction Générale d'Aviation Civil (Morocco), FAA=Federal Aviation Administration (USA), EASA= European Aviation Safety Agency (Europe).

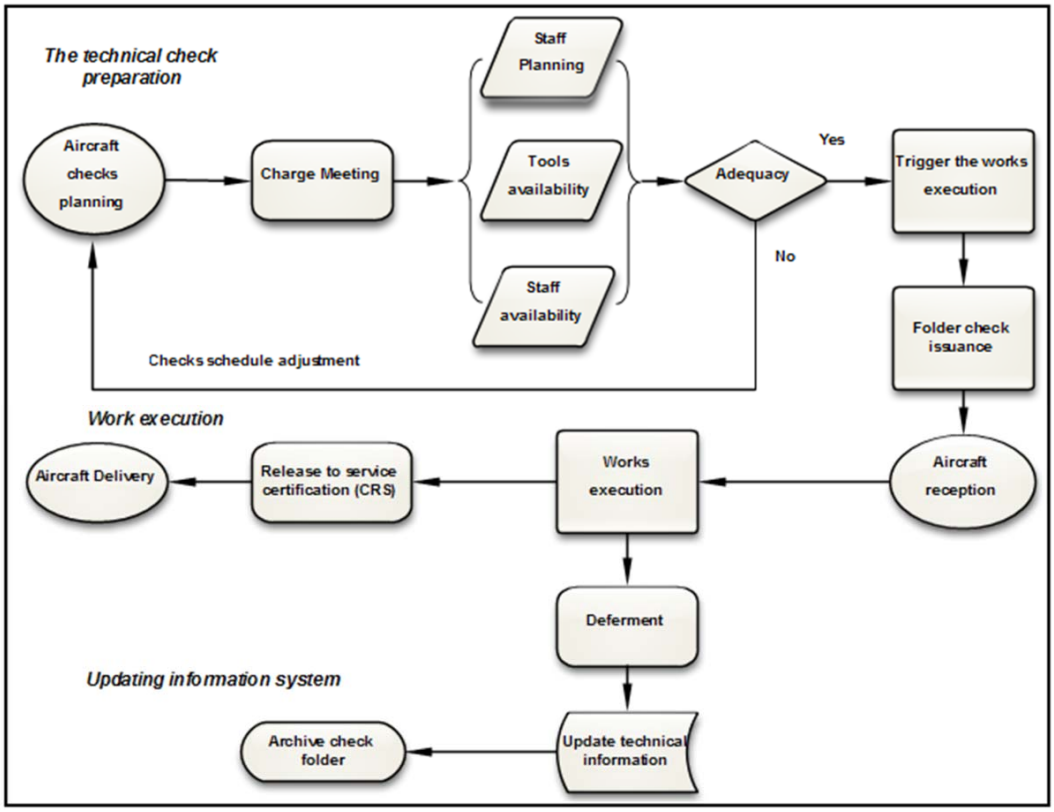

Fig. 3 Aircraft check process

Table 5: Initial list example

Activities	*Tasks*	*N*
Tools preparation	Manage industrial tools and resources (Docks, Stepladders, etc.).	44
	Manage the audit operations, periodic maintenance and calibration of tools.	45
	Manage tools Stores.	46
	Distribute tools.	47
	Monitor and ensure the terms of stores tools entry.	48
	Ensure the storage conditions and ensure the physical removal of resources and equipments in storage limit.	49
	Control the movement between stores tools.	50
	Ensure the provision of tools stores.	51
Aircraft maintenance	Perform pre-flight and Transit operations.	52
	Carry out daily, Weekly, A, C, and D checks.	53
	Achieve the planned interventions.	54
	Troubleshoot aircraft in operation.	55
	Carry out cabin configuration change for special flights.	56
	Wash the aircraft exterior.	57
Aircraft cabin maintenance	Carry out maintenance of seats, carpets, plastic rugs and curtains.	58
	Performs aircraft toilet servicing.	59
	Install and remove the stretchers and provide oxygen to patients.	60
	Perform cabin version change.	61
Aircraft structure maintenance	Repair the structure of aircraft in operation and in checks.	62
	Overhaul and repair removed aircraft structural elements in the workshop.	63
	Carry out aircraft welding and painting.	64

We follow an analysis phase. The goal is to make a synthesis and reduce the number of activities by eliminations and consolidations. The elimination criterion, is Pareto law (20/80) which is usually checked and it allows to select only the most significant activities in view of their relative importance [20]. We grouped some activities from the initial list because they involve the same notion of activity and use identical ways at the distribution of the checks. Unlike, we eliminated others because they represent too small cost that will have little impact on the profitability of services. Hence, we carried out the ***final list of activities***.

Once the initial list of activities defined, several interesting documents can serve as a guide including the summary of activity (**Table 6**). For each activity, and through questionnaires and interviews with operational personnel, we have defined each activity, knowing what triggered it (the supplier), who executed the next activity (the customer) and finally the cost driver. After establishing the list of activities that contribute to the achievement of cost object and the summary sheet for each activity we deduced the cost drivers.

Table 6: Control the aircraft activity summary example

Activity name	***Control the aircraft***
Definition	Control maintenance tasks such as run up, boroscope, adjustments and tests.
	Assist production entities.
Suppliers	Engineering.
Clients	Production.
	Exploitation.
Cost driver	Number of inspections carried out.

4.3 Third Step: Define the drivers associated with each activity that will measure resources consumption

The cost drivers' choice is critical, because they will determine the activity overall cost and the share to be assigned to a particular service. This determination is made using analysis cause / effect methods as Ishikawa Fishbone diagram and Pareto Flowcharts. After achieving the first two steps, the analysis reveals the following information (**Table 7**, **Part A**).

Table 7: Cost drivers

	(A)	**(B)**	**(C)**	**(D)**
Activities	***Selected Cost drivers***	***Annual Volume (1)***	***Cost (MAD) (2)***	***Unit Cost (2) / (1)(MAD)***
Aeronautical purchase	Number of control	10000	432000	**43.20**
	Number of Consumable references	20000	144000	**7.20**
	Number of equipments	5000	600000	**120.00**
	Number of parts supplied	10000	1500000	**150.00**
Production	Workforce Time (aircraft)	300000	34000000	**113.33**
Support	Number of aircraft scheduled	500	700000	**1 400.00**
	Number of work Entries (launching)	3400	1400000	**411.76**
	Number Material Items prepared	6000	1200000	**200.00**
	Number of references identified	5000	1800000	**360.00**
	Workforce Time (tools)	15400	7000000	**454.55**
	Number of job cards made	1000	1600000	**1 600.00**
	Number of documents sequenced	180000	2500000	**13.89**
	Number of inspections carried out	12000	7500000	**625.00**
	Number of work entries (monitoring)	8000	800000	**100.00**

4.4 Last Step: Define the relationship between cost object, activities and resources

The main difficulty encountered in the (MAMC) financial department, is the lack of cost accounting on which we can rely to evaluate the activities. However, the budget control service was useful in this evaluation. Two types of costs will affect the products or services cost price:

- Direct costs allocation: consumable materials.
- Overhead costs allocation: activities.

The allocation of aircraft equipment consumables, repairable and revisable to the technical check can be obtained through the Technical Information System, where every aircraft equipment use is charged to the concerned check (A, C or D) and to the concerned aircraft (Boeing 737-400,700 or 800). The second phase of services cost calculation consists of allocating the cost of activities to the cost objects. The method presupposes that all information is available for the definition of various relationships. For our cost object ***the standard technical check (Type A)***, the procedure follows two sub steps: The first one is to calculate the activities' cost driver quantities consumed by cost object during one year (**Table 7**, p**art B**). The second sub step follows the same logic as the previous one, but at this time, it is at activities level. The aim is to determine the resources consumed by different activities (**Table 7**, **part C**). Finally, the unitary cost of each cost driver is calculated (**Table 7, part D**). At the end, the Boeing737-700/800 ***Aircraft standard technical check (Type A)*** cost-calculating table can stand as follows (**Table 8**):

Table 8**:** Technical Check (type A) cost for aircraft Boeing 737-700/800

Activities	***Cost Nature***	***Measure Unit***	***Used Quantities***	***Unit Cost***	***Total Cost (MAD)***
(Direct costs)	Aeronautical consumable materials				**10 000.00**
(Direct costs)	Overhauled repairable materials (maintenance costs only)				**950 000.00**
Production (Direct costs)	Maintain the aircraft	Workforce time	200	113.33	**22 666.67**
Aeronautical purchase (Overhead costs)	Establish orders	The order	50	43.20	**2 160.00**
	Receive Orders	The order	40	43.20	**1 728.00**
	Manage Consumables	The reference	40	7.20	**288.00**
	Managing Service and Repair	Equipment	10	120.00	**1 200.00**
	Parts store	The part	40	150.00	**6 000.00**
Support (Overhead costs)	Develop the program of visits	The plane	1	1 400.00	**1 400.00**
	Launch works	Work entry	20	411.76	**8 235.29**
	Prepare the materials	The item	40	200.00	**8 000.00**
		Reference	20	360.00	**7 200.00**
	Prepare tools	Time workforce	8	454.55	**3 636.36**
	Prepare job cards	Job card	4	1 600.00	**6 400.00**
	Plan and monitor production	Working paper	70	13.89	**972.22**
	Control the aircraft	Control	5	625.00	**3 125.00**
	Enter works	Work entry	40	100.00	**4 000.00**
Total cost					**1037011.55**

The (**Table 8)** presents the (MAMC) expenses account as a list of valued activities. This new reading will lead naturally to resource allocation analysis against the objectives of the organization. Thus, the application of activity-based costing leads to the determination of overhead costs, resources consumer, on which we focus our attention. For example, to determine the accurate ***check A*** cost of Boeing 737-800 for a client, we can easily see the cost articulation of activities and remove those who aren't used to perform this check. For this case we can

remove the activities “Develop the program of visits and Prepare job cards” cost and know the charge for every additional aeronautical purchase order requested. With this data, the manager gains a greater overall understanding of the expenses and can compete by having a reliable information system on the costs of services offered by his organization.

5. Conclusion

Reliable cost information is a powerful tool in increasing organization's profitability and competitiveness. Traditional cost accounting methods, which use a single key, such as flight time, for overhead costs allocation without direct causal link with the real resources consumption, can induce a subsidizing effect between various organization’s services offered. This paper offers a new method for calculating costs according to the ABC approach for aircraft maintenance activity and helps the decision makers to determine the price of each service based on the allocation of overheads. This study takes a Moroccan Airline Maintenance Centre as a case study.

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