## PARAMETRIC ESTIMATION OF SPARE PARTS IN CUSTOMER SUPPORT ACTIVITY

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## ABSTRACT

The SCM is an integrated approach, processoriented, purchase, production and delivery of products and customer services. The scope of SCM include subcontractors, suppliers, internal operations, business customers. customers. distribution and end users. The SCM covers the flow management of materials, information and capital. The goal that wants to achieve is the Customer Satisfaction. In this point of view, we have analyzed the issues related to estimate of parts during the offered-phase. Then we went to the definition of an algorithm that allows the estimation of parts in short time.

The Customer Support is the key element, present throughout the cycle life of the aircraft for customer loyalty and ensure a business long term. The current commercial process with the client always passes through an early stage, called RFQ (Request for Quotation), fro which is sufficient an *"estimate of costs"*, and a more advanced stage, called RFP (request for Proposal) for which instead is necessary a *"detailed assessment"*. To date, in both cases working with a very accurate expensive estimation.

## **INTRODUCTION**

The demands that always occur in the logistics market, as the drive towards a more value for money performance have always been and always will be pressing. The overall objective is to maintain or enhance current service levels without increasing the cost of logistics in the face of increasing demands and needs of recipients increasingly pretentious.

In a market constantly and rapidly evolving needs of the customer satisfaction is the minimum essential in order to be competitive. Loyalty effectively allows for a real investment return (ROI), in particular as regards the medium to long term, but it is especially important because the costs of acquiring new customers are almost always higher than those incurred for the maintenance of old. Customer Relationship Management (CRM) was founded with the aim to help companies in customer loyalty, with the aim to create new opportunities for intervening where customers anticipate and meet needs. CRM allows the management of customer relationships in order to always have this situation, anticipate future needs and maintain alive in the final customer's attention for the company. A strategy of customer loyalty always sees in POST-SALE his central issue. The supply of spare parts to the customer is a crucial step in the delicate process of customer loyalty as well as a link in the chain of offered services by the very delicate logistics. At first the company had to pay that cost to produce a good or service that was only on its material production. Today the spectrum of performance of a company goes beyond the proper production of new products. A key factor in the high availability of products and their use is the optimal supply of spare parts. The parts, at first glance, are considered a mere cost factor. Seen from another perspective, however, must be considered that an efficient management of spare parts helps to ensure high machine availability and avoid the high costs due to the arrests of the devices. A correct spare parts logistics plays a decisive role in the interest of high economy. The handling and storage of spare parts for each company is a cost factor that raises a question: is it necessary to keep large stocks of spare parts? The correct answer depends on many factors: geographical location of the company, links to global systems of transport, delivery, standards on imports. Many companies offer their customers possibility of solutions for the financial management of spare parts and optimized according to individual needs. The primary interest is to configure a flow distribution in the most functional and comfortable as possible for the customer. n this regard it is important that spare parts can be ordered through the faster channel or be provided directly to the customer during the INITIAL Provisioning. This means that there is almost no need to keep their own stock of spare parts and the supplier company is concerned to deliver spare parts to customers in a short time set. It's necessary to draw up a document whose purpose is to define the process of quantification of support materials and required spare parts to maintain the operational efficiency of the product in its life cycle in operation. The process of Material Support has a target of meeting the performance requirements of the product during operation cycle, and to that end provides the information and documentation relevant to the

definition, classification, formation, organization and management of support materials and stock levels, predict the risk of non-compliance, lack of (low stock) or a capital lock (over stock). The Material Support, then, identifies and classifies the good and marketable material support, depending on the characteristics and technical configuration of the product and the level of provided maintenance by the analysis of tolerability and defines and proposes the quantity of materials necessary to support maintaining the product in operation depending on the level of request operational availability. In order to ensure continued availability of the required operating the product in operation, the Initial Planning of support materials and spare parts must be constantly updated in the report: to changes in configuration and product reliability in service; At the time of maintenance, handling, recycling and supply of materials relevant financial year; Under the scenario operational variables, maintenance policies and sources of supply.

During the lifecycle of the product, the Material Support detects and analyzes the pattern of consumption of materials and non-repairable defective repairable. It 'a need to formulate guidelines for the loan under the broader business process materials management, which must be set by software during the entire lifecycle of products in service. The software can solve logistical problems related spare parts and identify optimized decisions at the lowest possible cost for: Arrange alternative logistics support; Define values of tolerability for all systems and equipment; Establish policies for repair and localization of repair; Establish policies for spare parts and equipment constraints (initial supply);

Compare competitive proposals to support systems and chains; Assess the impact of preventive maintenance on the operational availability (costs / resources / staff).

The software we use provides output data and full opportunity to assess the cost of spare parts to support function of many measures of effectiveness (MOE: measures of effectiveness), giving curves and tables showing the range and optimal allocations of spare parts. The result of an exercise in quantification is expressed by curves showing the MOE on the basis of support costs (Cost Life Support).



In figure (curve cost-effective) to each identified point on the curve corresponds to a range of materials, depending on the investment put in place; great the investment, great the number of parts purchased and improved the MOE. The C / E curves display the values of efficiency calculated from the model of the set of stocks in the investment function and to identify critical points in the case (eg point of flattening of a curve that represents the value of the investment above which do not result in more significant increases in MOE in question). The result from the preparation of model elaboration of the mathematical model must then be analyzed in order to optimize the MOE through appropriate targeted interventions, such as: Allocate minimum quantities; Running multiple simulations with separation of items critical / non-critical items and repairable / non-repairable; Identify the "COST

DRIVERS (high defect and high cost) and check carefully the relevant parameters and results; Availability Balance values between the bases in the presence of significant imbalances.

At the end of the process activities, Material Support issues the Recommendation Document quantification and Support Materials that illustrates the calculation method and results, different for each type of exercise required.

The shopping process with the client always passes through an early stage that the RFQ (Request for Quotation) for which the estimate is of type ROM (Rough Order of Magnitude) and for which sufficient "estimates of costs" and a more advanced stage that RFP (Request for Proposal) where the assessment is of type IP (Initial Provisioning) and which is needed is a "detailed assessment."ROM is an assessment of first approximation and can be obtained in the evaluation phase of a product by the customer who wants to know the quantity of parts required (and the corresponding costs) to support it during operation (costs are estimates). The evaluation IP is the common situation of initial acquisition and distribution of spare parts by the customer. The result is a quantification of the materials. Today we work with a very accurate estimation expensive. Considering that not all business negotiations are successful, early in the RFQ can be applied a method of approximate calculation that allows us a significant reduction in response time and cost.



## SCOPE

Our attention has been devoted to aviation, where the method of calculation used to determine the cost of service parts is very precise but extremely costly in terms of workload and performance time (accurate estimate). Because of all bids for only 18% is successful, the remaining 82% we intend to find an algorithm whose response times are much narrower (10 days to 1). If we assume a base of 35 evaluations per year of which only 5 are RFP and the remaining 30 have RFQ, we see the savings in economic terms the use of a method of calculation by this simple calculation makes it a good idea of the current situation and that ideally reach:

<u>-TODAY - (35 EVALUATION x 10 days) = 350</u> <u>days</u> around 200keuro <u>-TOMORROW - (5 EVALUATION x 10 days) +</u> (30 EVALUATION x 1 g) = 80 days about 50 <u>keuro</u>

The mathematical algorithm that will replace the regular calculation tool will be implemented through a simple application such as Excel.

At the beginning, we will try to reduce as many variables freezing a logistical scenario, secondly, the launch will proceed with a discrete number of simulations, in relation to the number of real variables in the process. The last step will be to find the envelope of all simulations in order to obtain an algorithm that allows us to obtain a result parameter. For simplicity of calculation it was decided to divide the parameters of the scenario logistic constants and variables: ✓ CONSTANT PARAMETERS: sites.

maintenance policy, maintenance times, lead times, scheduled maintenance and overhauls, transit times, politics, storage, life support, reliability data, cost of parts, the average duration of missions;

✓ VARIABLE PARAMETERS: fleet size, factor use of the fleet, fleet availability.

It will perform a series of simulations that allow to quantify the cost of parts supplied in a given scenario logistics for a set period of time (three years). In particular, the simulations will be made on time assuming a fleet of 2, 3, 5 or 7 aircraft should fly 300/500/700 hours annually ensuring fleet availability (availability of the fleet) 70%, 80% or of 90%.

## **SCENARIO**

All parts, or more generally, all systems are generally classified into non-repairable and repairable. Non-repairable systems are those that are not repaired when they fail, this does not necessarily mean that they cannot be repaired, rather than no economic sense to do it and that the repair would cost about the same as purchasing a new unit. In turn, contain a category of nonrepairable systems such consumers: they are all effects of non-repairable low value. Repairable systems are those that are repaired when they fail, ie when no longer operating at 100%. A system is not operational when a component or subsystem is damaged, it is replaced or repaired, a serviceable system is generally a system with a high economic value to which the cost of replacement / repair of a component is certainly more convenient ' purchase of a new system. The tool we use reason of requires us, by similarity of characteristics of data input, a subdivision of parts for repair, NO REPAIRS AND CONSUMABLES for the quantification of the parties. We anticipate that the total number of simulations is 108.

## SIMULATION

Here the curves C / E (cost effectiveness) of output produced by the software whereas a fleet of seven aircraft flying 300, 500 and 700 FHS to highlight what is the trend of increasing costs of flight hours per year (to repair, not repairable and consumable).

Classe	NÇ AC	FH	FH*3years*NAC	A 70%	A 80%	A 90%
R	2	300	1800	0,836547	1,026453	1,443519
R	3	300	2700	0,89365	1,1099	1,567094
R	5	300	4500	1,021917	1,294655	1,817093
R	7	300	6300	1,130463	1,413664	2,029369
R	2	500	3000	1,1703	1,407923	2,118847
R	3	500	4500	1,276772	1,569516	2,357678
R	5	500	7500	1,488799	1,891193	2,671201
R	7	500	10500	1,706634	2,109535	3,027328
R	2	700	4200	1,419961	1,824909	2,589634
R	3	700	6300	1,634076	2,068114	2,905415
R	5	700	10500	1,989319	2,400609	3,48476
R	7	700	14700	2,248797	2,848693	4,247474





We have done the same simulations for the Not Repairable and for Consumable.

The goal is to make an envelope of all simulations, while reducing the number of variables and thus the number of charts on which to operate. Now we eliminate in this respect the distinction between repairable materials, consumables and non-repairable, thus obtaining a table of cumulative cost in which each item of cost is the sum of the costs of all 3 types of materials.

NC AC	FH	FHxSyears	(A 70%)	A 80%	A 90%
2	300	1800	1,00	1,23	1,70
3	300	2700	1,09	1,34	1,86
5	300	4500	1,28	1,60	2,19
7	300	6300	1,46	1,80	2,47
2	500	3000	1,41	1,69	2,45
3	500	4500	1,58	1,92	2,75
5	500	7500	1,91	2,35	3,19
7	500	10500	2,25	2,70	3,68
2	700	4200	1,74	2,19	3,00
3	700	6300	2,04	2,52	3,40
5	700	10500	2,56	3,02	4,16
7	700	14700	3,01	3,66	5,11

This makes it possible to build only three histograms Plot the total costs according to the FH.

Sorting the data by increasing the total Fh we incorporate two variables into one, namely the number of aircraft and Fh, allowing the construction of a single histogram showing the evolution of the cumulative total costs to changes in total and FH and request Availability.









Now we define the mathematical law which best interpolates all data points found with an error not exceeding 10-15% and therefore an explicit algorithm that allows us to calculate the outside and within the range we considered, the cost support of parts for a fleet with certain benefits.

# THE ALGORITHM

To define the algorithm were all plotted as a function of cumulative costs FH tot getting three curves, each of the level of required availability. The first approach was to diagram the evolution of points and a linear law interpolate them, drawing attention to the deviation of real points of the curve and checking that the error did not exceed 15%.



The cost may be acceptable to admit an error not greater than 15% which, when offered, is admissible in relation to the amount of time saved for the calculation. The graphs show that the real points which deviate from the curve are those relating to Availability of 90%. The interpolation of points based power law shows the following situations:



1	A B	C	D	E		G	н	
	A	Legge	di Potenza	Alg	oritmo	X=FHtot	Costo	
	A70%	y = 0.02	17" × "(0,5065)	= 0.0217	(G3) *(0,5066)			
	A80%	y = 0.02	89" × "(0,4967)	= 0,0289*	(G4) *(0,4967)			
	A90%	v = 0.64	42" x 4(0.485)	= 0.0442	* (GS) 4(0.485)			

Again the errors were graphically highlighted by the curve corresponding to 90% Availability (being that of presenting the largest deviations). Here are also interpolations of points logarithmic law, exponential law, law of 5th degree polynomial. From this analysis, we note that the algorithms are more relevant than those that respond to a linear law, 5th degree polynomial and power.



At this point a number of FHtot entering and remaining within the range considered, we examine the response of each (the best is one that provides output values closer to known those).

We try to include as the value of FHtot a number equal to 2700 which is given by producers support 3 years, 3 v3livoli FH 300 per year. From the simulations it is evident that the real values for an Availability of 70, 80 and 90% are circled in Figure:

NSAG	FH	FH*3*N°AC	70%	80%	80%				
2	300	1800	1,00	1,23	1,70				
3	300	2700	1,09	1,34	1,86				
2	500	3000	1,41	1,69	2,45				
2	700	4200	1,74	2,19	3,00				
5	300	4500	1,28	1,60	2,19				
3	500	4500	158	1,92	2,75				
7	300	6300	1,46	1,80	2,47				
3	700	6300	2,04	2,52	3,40				
5	500	7500	1,91	2,35	3,19				
7	500	10500	2,25	2,70	3,68				
5	700	10500	2,56	3,02	4,16				
7	700	14700	3,01	3,66	5,11				

The algorithms respond as follows:

Α	Legge di Potenz	a X=EHtot	Costo	Valore	Reale	Errore			
A709	y = 0,0217* x ^(0,5066	) 2700	1,19	1,05	•	circa 9%			
A809	y = 0,0289* x ^(0,4967	) 2700	1,46	1,3	4	circa 9%			
A909	6 y = 0,0442* x ^(0,485	2700	2,04	1,8	5	circa 9%			
Α	Legge Lineare	X=EHtot	Costo	Valore	Reale	Errore			
A70%	y = 0,0001x + 0,8247	2700	1,09	1,05	1,09				
A80%	y = 0,0002x + 1,0367	2700	1,58	1,34	circa 14%				
A90%	y = 0,0002x + 1,4508	2700	1,99	1,86		circa 7%			
A	Legge Polinomiale di 6ºgrado X=FHigt Costo V. Real								
A70%	y = 15-20x3 - 75-18x4 + 25-11x3 - 25-01x2 + 0,0005x - 0,002 2700 1,06 1,05								
A80%	¢ y = 15-20x3 - 75-16x4 + 25-11x3 - 25-07x2 + 0,0008x + 0,0765 2700 1,41 1,34 Circe 5%								
A80%	y = 35-20x3 - 25-10x4 + 45-11x3 -	35-20:5 - 25-15:4 + 45-11:2 - 35-07:2 + 0.0016: - 0.2553 2700 2,53 1.55 circa 36%							

The law and the linear power supply values that fall within the range of safety assumed initially. Conducting further tests with different values of FH, has identified the suitability of the algorithm power law (because it always shows an error of less than 15%), fully respecting the requirements and can be considered acceptable in an estimation ROM phase.

## CONCLUSION

We can conclude by saying that in a RFQ when it is not certain that the commercial negotiations to succeed, you can avoid the method of estimating accurate, very precise but extremely costly in terms of time spent and therefore cost the company. By using this tool Excel can get quick feedback on the estimate of the cost of spare parts with good accuracy (around 15%). The margin is quite acceptable in relation to the amount of saved time and the ability to almost instantly give an order of representative magnitude of the associated cost with the allocation of spare parts for logistical support in terms of assigned operational scenario.