Decision Support System for Offers of Fleet Availability Services

Andre Pozzetti, Ioana Bilegan, David Duvivier, Abdelhakim Artiba
LAMIH UMR CNRS 8201, University of Valenciennes and Hainaut-Cambresis
Valenciennes, France
andre.pozzetti@univ-valenciennes.fr

Barbara Matrat, Sébastien D'Arco, Sébastien Forato
Performance Based Services, Eurocopter
Marignane, France
Barbara.matrat@eurocopter.com

***Abstract*—The growing competitiveness within the aeronautic industry is inspiring companies to implement and offer Performance-Based Services. Whilst not necessarily a new concept, it is relatively new to the commercial aeronautic industry and presents prime suppliers with difficulties in predicting performance, risks and associated costs when performing whole of life costing during a service offer bid competition. In this paper, we propose a research to develop a novel methodology for a decision support system during the offer of Fleet Availability Services, remaining within the scope of Performance Based Contracting, achieved through the use of modeling, simulation, and optimization.**

Keywords - Performance Services; Aeronautic; Whole Life Costing; Performance Based Contracting

I. Introduction

As the Total Cost of Ownership (TCO) increases with complex aeronautic systems, companies within the industry are undertaking various strategies to gain a competitive edge. This is driving aeronautic customers to focus their needs on performance of the acquisition and sustainability of such systems. Whilst performance based sub-services, such as Parts By the Hour (PBH), Repair By the Hour (RBH) etc., are well-defined and relatively well-optimized throughout industry and literature [1 - 4], the ability of the industry to optimize global services, such as Fleet Availability, are yet to be established, and therefore competitive advantages are there for those whom provide Performance-Based Services (PBS) ensuring fleet operability.

Performance service methodologies, such as Performance-Based Contracting (PBC), or Performance-Based Logistics (PBL), are not new concepts to numerous differing industries globally [5][6], however the demanding military and increasingly demanding civilian aerospace acquisition and sustainment requirements present both industries with a significant challenge. This is inherent in the design of PBC and generally results from each contract being different [5]. Additionally, the services, which can be considered as a support strategy, are completed and comprised of integrated discipline sectors, such as logistics, maintenance, and engineering support [5], [6], [7], [8]. Generally measured through Key Performance Indicators (KPIs) [5], [6], [9], each covering different aspects, such as process engineering, the maintenance of the support systems, and the supply chain. It is however difficult to calculate the impact that decisions may have whilst operating within a complex system, which then contributes to the uncertainty for operations and costs.

The goal of this research is to develop a novel methodology for decision support in the offer of Fleet Availability Services (FAS), in the frame of Performance Based Contracting using modeling, simulation and optimization.

The structure of this paper is as follows: First, we provide an introduction to the problem with a literature brief to both define, and validate the problem, and topic. The middle sections discuss the key objectives of the research, following with our proposed methodology. Finally, preliminary results and concluding remarks are discussed at the end of this paper.

II. Literature

Performance Based Contracting can be considered as a support strategy, utilized to achieve measurable outcomes for a product of service. In the aerospace environment, common result areas involved are: Availability, Reliability, Maintainability and Supportability [5], [6], [7], [8]. Generally, these are interpreted as:

- Availability – The availability of an aircraft at a point in time at a defined location.
- Reliability – The measure of time between system failures.
- Maintainability and Supportability – Engineering, Maintenance, Logistics and Supply Chain efficiency.

Outcomes are comprised of integrated Key Performance Indicators, and are usually defined in a negotiation process between both parties, during both the contract tender phase and again throughout the contract award negotiation phase. For example, the Maintainability and Supportability outcomes, as displayed above, may be comprised of KPIs covering the various aspects of engineering and maintenance processes as well as a mixture of supply chain measures, such as:

- Demand Satisfaction Rate
- Turnaround Time on Parts Delivery
- Engineering Change Requests
- Design Modifications
- Cannibalization, et cetera.

 ISBN: 978-1-61208-319-3

With these outcomes and KPIs, described above are well-established and understood [5], [6], [7], [8], [9], the majority of literature has focus on the availability of sub-services rather than a fleet availability service as a complete system [2], [3], [4], [10]. Furthermore, little knowledge is developed on the various interactions within that complex system. Datta and Roy [10] proposed a methodology on the effect of customer-focused risks in cost estimates, highlighting other potential problems in the costing and development of availability type service contract. The highlighted problems are:

- The reliability of data,
- Assumptions regarding equipment failure,
- Considerations of uncertainties through the system life-cycle,
- Uncertainties of the customer's contribution to performance,
- Communication between the customer and supplier,
- Prediction of future maintenance and the inability to understand the cost impact of customer risks.

Due to the uniqueness of Performance Based Contracting and/or Performance Based Logistics contracts, one can assume that corporations are exposed to a significant amount of risk and potential over cost for managing, maintain and supporting such contracts across multiple platforms, with multiple customers. Consequently, a need exists to develop a methodology, design and implement a system for decision support, which may integrate the information communication systems environment of the supplier and customer. Additionally, the methodology should allow for the uncertainties and, in order to meet the needs for decisions in various scenarios, the methodology must use a multitude of modeling and optimization techniques.

III. Objective

The main objective of this proposed research is to develop a process of decision support to achieve a performance goal of overall availability using modeling, simulation and optimization of a service delivery system in aeronautics. In particular, it is proposed to conduct a research work aimed at developing a methodology for optimizing the performance of services ensuring that fleets of aircrafts are operational.

The preliminary step is to analyze what are the achievable performances of availability, given the intrinsic characteristics of the system and its associated support. Performance indicators need to be formally identified and a method for calculating the level of performance will be proposed. Next, functional architecture will be defined, which will provide the framework for decision support. Each element of the architecture will correlate with the various features identified as mandatory, and it is envisaged that a module type information system be designed:

- A module allowing the collection and analysis, either periodic or real-time,
- A module for the pre-processing of the data characterized by the system,
- A module for the modeling phase of the defined problem,
- A management module for optimization for maintenance and logistics, both strategic and operational,
- A simulation phase will also integrate the process of decision support in the specific operating environment.

The simulation will be used for non-deterministic study decision behavior of human operators, an essential element in this complex system. System architecture for decision support will also be developed, which is intended to be flexible, responsive and robust.

IV. Methodology

This research will require a multidisciplinary approach, comprising a variety of methodologies. Due to the evolving nature of a fast, highly competitive industrial environment, the overarching methodology employed will be considered as 'learning by doing', or 'agile', however more specific methodologies will be employed during various phases of this research.

Many of the systems and processes are implemented across several operating entities, and are required for the monitoring and measurement of performance indicators, and therefore, constitute to an essential element in the study. The focus of this element is on the problem of aggregation of dispersed data into a central knowledge information system. This first step will rely on the use of the following methodologies:

- Systems Engineering,
- Data Modeling, and
- Hybrid OnLine Analytical Processing (HOLAP)

A second important step of the research is to define formalized models for simulation, incorporating various elements such as the penalties and incentives. As the research is conducted in partnership with Eurocopter, the tools utilized for any modeling, simulation, analysis and optimization are already pre-determined; additionally the methodology developed, must be compatible with existing technologies currently employed amongst the company.

The third phase of work will be concerned with the analysis of the resulting model, so validation and feedback from an aeronautic perspective can be obtained. For this part, a study will be based on Systems Engineering methodologies, but also include comparative analysis and case studies with existing platforms offered at Eurocopter.

Potential benefits of the implementation of our proposed methodology are suggested:

- Possibility for suppliers to deliver and manage several types of performance services based on defined availability,
- Possibility for both the supplier and customer to have a system providing traceability, monitoring and optimization of service delivery, and
- Find the best compromise between technical performance as expected by the customer, and the commercial supply of the industrial supplier.

V. Preliminary Results

Following the proposed methodology, two initial models were developed in one tool each, Microsoft Excel, and Systecon's SIMLOX. Let us describe the Excel model as "Model A", and the SIMLOX model as "Model B". Model A was developed as a statistical based model, focusing on the breakdown of measurable time under which the aircraft is either considered available, or unavailable. Model B on the other hand, is by nature of the tool, a Discrete Event Simulation (DES), and focuses on the differing states the aircraft can be considered under each moment in time, which can be measured in Hours, Days, Months or Years.

To gain an understanding of the impact of decisions during the development of Model A, a sensitivity analysis was performed on the main parameters, and added to the functionality of the model. Selected initial results in Figs. 1 - 3 show the sensitivity these three input parameters have on model output parameter, Availability. The input data originates from a hypothetical emergency services operational environment for a fleet of 18 helicopters, covering logistics inputs (Fig. 1), unscheduled events (Fig. 2) and additional helicopters (Fig. 3).

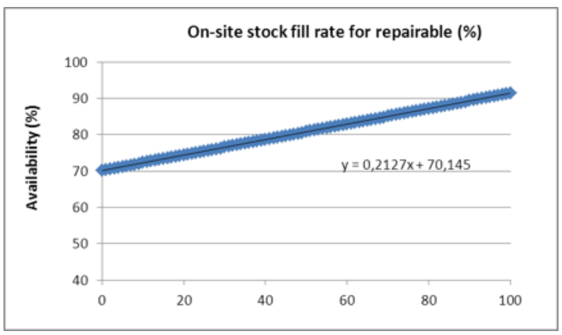

Figure 1. Sensitivity of the Global Fill Rate for Repairable

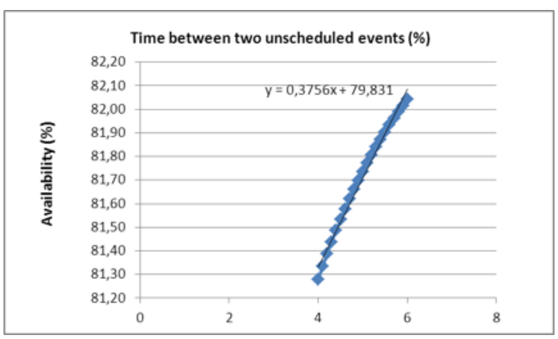

Figure 2. Sensitivity of the Time Between Unscheduled Events

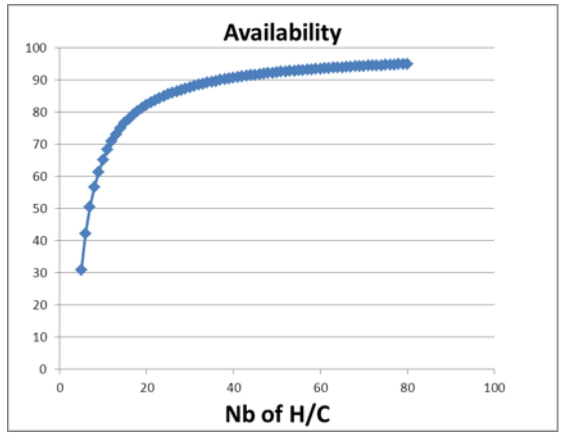

Figure 3. Sensitivity of the Availability

The initial results from the current development on Model A demonstrate how the model can allow an expert user to quickly ascertain sensitivity, and therefore identify the key drivers for the development of Fleet Availability Services.

VI. Conclusions and Perspectives

This is a preliminary work and further development and analysis is required on penalty estimation and the impact based on the sensitivity of key parameters in the model. The efforts must also be replicated in Model B, however assumed to be more complex due to the nature of the SIMLOX tool. We anticipate the ability to import/export raw data for this step, therefore an interface and sub-tool must be developed for the sensitivity and impact analysis of Model B.

Once these steps have been formalized, and the models validated with Eurocopter, the new tools and methodology will be tested with chosen real world case studies.

References

[1] A. Ehrilch, 2005. "Method of Modelling and Measuring the Airline Spares Supply Process in line with Airworthiness Regulations and Aviation Standards," Diplom Kaufmann, Department of Business, University of Applied Sciences, Hamburg.

[2] H. Mirzahosseinian and R. Piplani. 2011. "A study of repairable parts inventory system operating under performance-based contract," European Journal of Operational Research 214: 256-261.

[3] M. Marseguerra and E. Zio. 2000. "Optimizing Maintenance and Repair Policies via a Combination of Genetic Algorithms and Monte Carlo Simulation," Reliability Engineering & System Safety 68 (1): 69-83.

[4] D. R. Nowicki, 2008. "Optimization Models in Support of Performance Based Logistics Optimization," PhD, The University of Wisconin, Madison.

[5] Aerospace System Division, 2007. "Performance Based Contracting Handbook - Guiding Principles and Performance Framework," Defence Material Organisation, Australia.

[6] I. Ng and N. Yip. 2009. "Identifying Risk and its Impact on Contracting Through a Benefit Based-Model Framework in

Business to Business Contracting: Case of the Defence Industry," In 1st CIRP Industrial Product-Service Systems (IPS2) Conference, Cranfield University.

[7] R. F. Stapelberg, 2008. "Handbook of Reliability, Availability, Maintainability and Safety in Engineering Design," Springer.

[8] M. Wetzer, G. R. Garrow, D. P. West, P. E. Weir, and C. P. Newton III, (2011). U.S. Patent No. 7,895,047. Washington, DC: U.S. Patent and Trademark Office.

[9] A. Pozzetti, C. Bil, G. Clark, (2013). "Fuzzy Logic Application in Performance-Based Contracting Process," In Concurrent Engineering Approaches for Sustainable Product Development in a Multi-Disciplinary Environment (pp. 303-314). Springer London.

[10] P. P. Datta, R. Roy, (2010). "Cost modelling techniques for availability type service support contracts: a literature review and empirical study," CIRP Journal of Manufacturing Science and Technology, 3(2), 142-157.