*Proceedings of the 2017 Winter Simulation Conference*
*W. K. V. Chan, A. D'Ambrogio, G. Zacharewicz, N. Mustafee, G. Wainer, and E. Page, eds.*

# SIMULATION OF PERFORMANCE-BASED SERVICES IN DISASTER RESPONSE OPERATIONS

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## ABSTRACT

Performance-based services are an interesting concept for partnerships between governmental organizations and the private sector to meet requirements in terms of budget plannability and service level guarantees. This paper discusses the use of simulation in the process of defining the technical and contractual configuration of those services with a case study in airborne services in disaster response operations. The simulation helps to overcome the limitations of analytical methods in modelling complex operational scenarios and logistics strategies.

## 1 MOTIVATION AND PROBLEM DESCRIPTION

Worldwide, natural catastrophes occur with increasing frequency and impact and have to be handled by governmental and non-governmental humanitarian aid organizations. Humanitarian aid becomes increasingly professional and a growing market for commercial companies. Disaster recovery operations must provide urgent aid within hours of an event without local infrastructure and enduring aid for months to years. Besides emergency kits, power and water supply, storage and transportation means, also command & control and communication solutions for the coordination of the humanitarian aid are required (van Wassenhove, 2006). The UN and the EU strengthen their capabilities by teaming up with the private sector.

The performance-based services (PBS) concept is based on the public-private partnership (PPP) arrangement to gain technologies and resources (logistics, communication, etc.) from private companies. The private partner in the PPP will guarantee the level of service (time to setup the service, availability of services) for a defined number of disaster events. To define a PBS contract, the service provider must allow for uncertainties in terms of the missions, the unpredictability of the location and timing of operations, the related dynamic setup of logistics system and the resulting risks coming from the asset and resource configuration. The following questions have to be answered: Which scenarios have to be considered? How to calculate the optimal assets and resources? How to include the deployment delay? How to define the right PBS penalties and incentives in the contract payment schemes? Analytical approaches have difficulties to describe those complex scenarios (Wong, E., Nguyen, V.-V. & Schirrmann, A. 2011). This study investigated the potential of the combination of analytical models and simulation in PBS contract creation.

## 2 CASE STUDY PBS FOR AIRBORNE SERVICES IN DESASTER RESPONSE

The focus of this study is on post disaster services for airborne surveillance (provision of situational awareness) & communication services using unmanned air systems (UAS). The UAS is built from an air system (AS) and a ground system (GS), both of which require logistics support (maintenance, spares) provided from operation bases outside the disaster zone as well as from the established mission operation base inside the disaster zone. During a PBS contract with a runtime of five years up to ten and in maximum two parallel operations are expected. The deployment of the services has to be realized within 48 hours after the disaster and a defined number of UAS has to run in a 24/7 mode for two to three month missions. A continuous operation with 90% mission fulfillment is expected. The PBS contract includes a fixed payment scheme plus performance incentives over a five years period.

The analysis and simulation tools from Systecon are used for the case study to evaluate how analysis and simulation can be combined. Additionally, the paper identifies and discusses the key parameters impacting the contract profitability: UAS technical performance, fleet configuration, deployment delays and pooling between operational bases, performance measures and penalty/incentive regime in the contract.

## 3 SIMULATION APPROACH

The contract development for the performance-based, airborne service uses a three-phase process, where simulation is mainly applied in the second phase:
In the first step, start solutions based on analytical methods (vari-metric model, non-dynamic operational scenario) are created. The UAS model (system structure and part performance characteristics) and the logistics structure for spares support have to be defined and the maintenance resource allocation has to be calculated. The result is the generation of the cost-efficiency curve for the setup. At the end of this analysis phase a list of valid UAS configurations with optimal logistics support structure and related logistics support costs is given. In the second phase of the analysis, the model has to be enriched with operational and mission profiles that are not part of the analytical methods. Detailed flight envelopes, deployment into the disaster zone, maintenance processes and resource constraints like maintenance shifts, transport and repair processes have to be defined and will be modeled as an event-based simulation model of the logistics system. Furthermore, different disaster scenarios - separate events with a two to three month duration either in parallel or in sequence - must be defined and simulated for the contract duration of five years. The calculated UAS and logistics system configurations from phase one together with the extended model from phase two are now used for a simulation campaign. This more realistic model supports the simulation of different stocking points for various fleet and logistic support structures and for multiple operational profiles to identify the optimal fleet structure and logistics setup. As a result, the calculated logistics support costs and the level of the mission fulfillment are more realistic for the final calculation of the contract value. In the third phase, the PBS contract has to be established and the risks of the contract profitability under different scenarios, UAV fleet configurations and contract models (profit impact, payment schemes, incentive / penalty functions) has to be assessed.
This study was performed with the Systecon OPUS 10 software suite that provides tools for the vari-metric model-based analysis and the event-based simulation of operational scenarios.

## 4 RESULTS AND CONCLUSION

The result of the studied approach is an optimized fleet and logistics support system configuration and the definition of the performance-based contract. The assessment of key parameters on contract profitability have shown interesting results, e.g., that the UAS technical performance (failure rate) is a critical factor for the PBS contract profitability. An increase of the failure rate by 10% will decrease the profit by approximately 30%. The deployment time for the logistics support system dramatically impacts the PBS contract profitability. Every additional day of delay for the deployment of the logistics system will decrease the contract profit by 16%. Sharing of AS and GS between the two operation bases prevents stoppage of the operations and incurring penalties and increases the profit by 27%. To sum up, the simulation significantly helps in identifying and reducing the risks in PBS contracts.

## REFERENCES

van Wassenhove, L. (2006). Humanitarian aid logistics: supply chain management in high gear. Journal of the Operational Research Society , Vol. 57, Nr. 5, S. 475-489.

Wong, E., Nguyen, V.-V. & Schirrmann, A. (2011). Inventory Rationing and Strategic Pooling of Spares for Performance-Based Contracts. NOFOMA 2011. Harstad, Norway.