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CZECH ARMED FORCES AND SOME ASPECTS OF HELICOPTERS ACQUISITION

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Abstract: *After several years of discussion and decision-making approaches Army of the Czech Republic to implement the purchase of multipurpose helicopters to replace the previously used, morally and physically obsolete attack helicopters Mi-24 / 34. The process of acquisition consists of many stages; it is not a simple matter and has its pitfalls. It is also a big, expensive and long-term acquisition in which the poor implementation can cause problems that are likely to affect the Army of the Czech Republic and its Air Force for many years. One of the decision-making process inputs is an estimate of Life Cycle Cost (LCC). For the estimation, many methods can be used. The paper deals with application of system dynamics to LCC estimation process. Partial models of utilization and support Life Cycle phases are presented, which can be further developed according to consecutive data availability. An influence of different helicopter operating modes on a Life Cycle Cost is demonstrated by means of simulation in Vensim application. The models, after verification and validation, can be used to support the acquisition process.*

Keywords: Helicopters; System Dynamics; Life Cycle Cost; Life Cycle Model; Acquisition.

1. Introduction

Helicopter air force will remain an indispensable part of the Czech Armed Forces, and it will be key contributing factor to carrying out foreign missions. Helicopter forces will be further developing in order to fulfil a wide range of operational missions, including tasks in support of the Special Forces and the Integrated Rescue System. The biggest share will be medium sized transport helicopters and multipurpose helicopters. Training, maintenance and modernization capability will be developed to meet the Czech Armed Forces and Alliance needs. Priority will be given to operations training at the Multinational Aviation Training Centre (MATC) focusing on standardization and efficient training of helicopter crew and ground technical specialist [1].

2. Replacement of Mi24 / 35 helicopters in the Czech Republic

One of the main reasons for the helicopters replacing in the Czech Air Force was, and still is, ending or reducing dependence on Russian technology and the transition to the platform one of the Western manufacturers. The unsatisfactory situation in the supply of spare parts for repairs and service for Russian equipment is even more complicated by situation in Ukraine and is also affected by the European Union embargo against the Russian Federation. Acquisition of new helicopters does not mean immediate shift away from the use of MIL Series helicopters, which are in service

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in the Czechoslovak and Czech Air Force since 1956. Helicopters Mi-24/35 will continue to operate primarily to keep the ability of flight personnel at least until the new multipurpose helicopter delivery.

3. The acquisition process of new multi-purpose helicopters in the Czech Republic

The aim of the project is the acquisition and implementation in the service 12 multipurpose helicopters, including weapons and ammunition with requested options and alternatives for tasks of combat support for ground and special forces and other specified tasks, providing initial and retraining of flying and technical personnel (including instructors) and providing initial logistics support. For every helicopter it is planned and requested 250 flight hours per year [2]. The contract will be implemented in the government-government mode.

Czech Air Force requirements:

- The twin-engine multipurpose helicopter;
- Type Certification and conformity certificates issued by national / military authority or the civil aviation authority
- Certification of weapon systems
- Ability to operate day and night, under adverse weather conditions of permanent airport, terrain and areas of limited dimensions out of the permanent airport network;
- Ability to operate in all climates, with the exception of the Arctic;
- Ability to fire support of ground forces [2].

Currently they seem into account these types of helicopters are considered:

- Airbus Helicopters H145M
- The Bell UH-1Y Venom
- S-70i Black Hawk: International military version assembled by Sikorsky subsidiary, PZL Mielec in Poland.
- Leonardo-Finmeccanica AW139M (Military)

It is evident that an integral and important element in the acquisition of multipurpose helicopters for the Czech Air Force is the price. In this case comprises not only the price of the helicopter, but also ensure the initial and retraining of flying and technical staff, ensuring initial and subsequent logistical support for its planned annual flight hours etc. For helicopter operations it will be necessary to develop a comprehensive land service, including service technology, to provide repair and maintenance facilities and training capacity. From this point of view some potential suppliers should have comparative advantage. For example, the signing of the Memorandum of Understanding between Bell Helicopter and LOM Praha company about service military helicopters manufactured by Bell. This includes installation, customization and maintenance of helicopters not only for the Czech Republic but also for Central and Eastern Europe [3]. The final helicopters price also significantly affects the electronic and sensory equipment of helicopters. Another important variable is the type and quantity of purchased ammunition or missiles, which can markedly affect the final cost of the purchase.

So, it is not only about the total amount of "buying" prices for the whole helicopters acquisition, eventually price for "one piece," but the total financial costs of the entire project, Life Cycle Cost *(LCC)* of the system.

4. Model of Life Cycle Cost Estimate

Although functionality of any military system is a key requirement when a new system is procured, dealing with economical restrictions*, which always present, the Life Cycle Cost is another factor which must be considered. The issue is that not only the initial acquisition price should be considered, but in-service phase cost, which regards to the most important phase of a system life cycle, i.e. operating it.*

The Life Cycle of a system is divided into six phases: concept, development, production, utilization, support and retirement. The utilization and support phases concern operation of a system and they run parallel. The phases of Life Cycle are in depth described in [4]. Dealing with helicopters, we will focus only on the utilization and support phases of LCC,

because the Czech Republic do not have capabilities for helicopter research, development and production, and the acquisition process has no influence on life cycle early phases costs. The same can be said for the retirement phase.
The presented approach uses a system dynamics model. Partially, the Czech Army operates four types of helicopters, A, B, C and D. The generic names are given because the authors were not able to verify data and the focus of the paper is on methodology of life cycle phases cost estimate. Table 1 present empiric data for cost of flight hour (FH). There is a direct cost of FH, which includes fuel, lubricants and other liquids and materiel, spare parts necessary for a helicopter operation. The reproduction cost represents required general overhauls (GO) of helicopter components given by helicopter producer regulations. GO is required after specific amount of fly hours or after reaching a component lifespan. It is expressed as the Operation Period between GO (OPBGO), represented by either a component flight hours or an age, which occurs first. There is no modernization cost included. This support scheme is used for helicopters A, B and C. An example of a required component GO of the C helicopter is given in Table 2.

Table 1 Empiric flight hour cost composition

	Helicopter A	Helicopter B	Helicopter C	Helicopter D
FH Direct Cost	154 029 CZK	94 729 CZK	105 479 CZK	135 223 CZK
Support Cost per FH	28 667 CZK	37 000 CZK	48 700 CZK	66 136 CZK
FH per Year	250	250	200	147

Table 2 Example of components GO costs for helicopter B

Component	Cost	OPBGO FH/Year	Real FH per OPBGO	FH Cost
Airframe GO	30 000 000 CZK	4 800/10	1 000	30 000 CZK
Engine GO	8 500 000 CZK	1 000/8	1 000	8 500 CZK
Reducer GO	3 500 000 CZK	3 000/8	1 000	3 500 CZK
Main Rotor Blades	5 200 000 CZK	1200/8	1 000	5 200 CZK
Tail Propeller Blades	1 500 000 CZK	1000/8	1 000	1 500 CZK
Total per FH				48 700 CZK

The D helicopter uses a different GO scheme, typical for modern helicopters. Required work, according to the producer regulations, is undergone every 1500 flight hours and the component is repaired or exchanged respecting actual findings and the component lifespan.
According to the Table 2 the support cost per FH is given by the supposed amount of flight hours between GO, which is in this case 1000 FH. This value in general can vary depending on an actual helicopter operation. The model presented bellow allows calculating this value according to supposed helicopter operation scenario and even in case of supposed amount of FH per year is not constant. The generic model can be further detailed and it is capable to support a LCC estimate of any considered helicopter supposed that the producer would provide required data.
The model was developed using a system dynamics methodology [5] in the Vensim DSS application. Dealing with the LCC analysis, the system dynamics is beneficially used in case of many factors influencing price and long time period of life cycle. A generic system dynamics model of a helicopter LCC estimate was published in [6]. The presented paper deals with utilization and support phases only and provides a further decomposed model.

The model of utilization phase is very simple, Figure 1. It uses an amount of FH per year (*FH per Y*), the flow *In FH per Y* is integrated in the *FH Total* variable and the *Utilization Cost* variable is a product of *FH Total* and *FH Cost*.

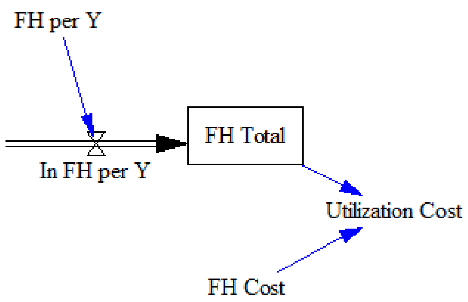

Figure 1 Model of utilization cost

An example of a helicopter airframe general overhaul model is in Figure 2. The variables *Time Counter Airframe* and *FH Counter Airframe* count time and flight hours from the last GO respectively. If the conditions for GO (set in *OPBGO Airframe)* are met, the value of the *Moment GO Airframe* variable sets the *Airframe GO Undergo* variable which influences the inflow *Invest Airframe*. The last one represents actual investment, based on data from the *Cost GO Airframe* variable. The total amount of investment is accumulated in the *GO Cost airframe B* variable, so it represents the total cost of the airframe GO.

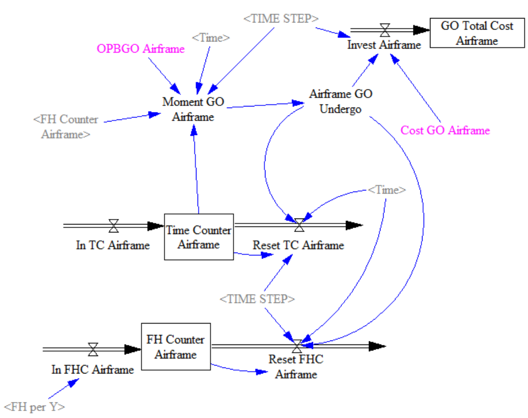

Figure 2 Airframe GO model

Analogic models were created for the other components; see Table 2, for helicopters A, B and C. The GO model for the D helicopter is different. There is only a rough estimate of work required cost available, given in Table 3.

Table 3 Estimate of required work for D helicopter

Flight Hours	1 500	3 000	4 500	6 000
Estimated Cost of required work (mil CZK)	20	50	125	50

5. Simulation results

Models of utilization and support phases were created for the A, B, C and D helicopters based on available data. For the comparison 250 flight hours per year and 25-year life cycle were assumed. The results of the simulation are in Figure 3. Although the A helicopters has a higher FH direct cost (see Table 1), the support cost of the D helicopter causes almost the total cost of these phases during the life cycle.

Dependency of the utilization and the support costs on the operation mode given by various amount of flight hours (200, 300 and 400 FH per year) is illustrated in Figure 4, using the D helicopter cost model.

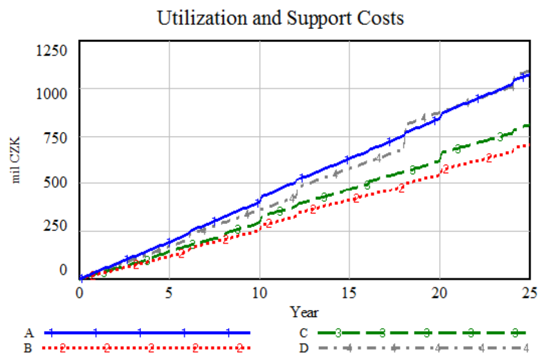

Figure 3 Comparison of utilization and support costs

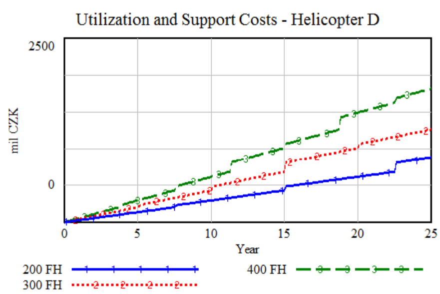

Figure 4 Utilization and support costs by flight hours per year

The model outputs provide not only the relation between utilization and support costs according to a helicopter operation costs, but also their time behaviour.
The briefly introduced approach of life cycle phases modelling can be applied to consideration of Life Cycle Cost of potentially acquired helicopters. A crucial point is availability and completeness of data or at least an estimate for all phases (the acquisition cost is substantial). The model can be further decomposed and detailed according to a data collecting process. Models of other items as weapon and communication systems, training systems, ground infrastructure and personnel costs can be developed as well.
Advantages of the above introduced model using system dynamics are more accurate cost estimate in time, potential of model decomposition and refining according to data availability and visualization of the system elements and couplings. A further step of an application of system dynamics to LCC model would require to complete the system structure and to take into consideration resource limits, which vary in time and which include finance, available and prepared personnel and an infrastructure.

6. Conclusions

The acquisition process of multipurpose helicopters belongs, with respect to the complexity and amount of financial resources, in the big Czech Republic defence projects. It may affect the development of the Czech Air Force for many years ahead. It is clear that after some time the previously used MIL helicopter platform will be left, as has been variously spoken in connection with Concept of the Czech Armed Forces Development 2025 [7]. Potential winners of this current tender for the purchase of 12 multipurpose helicopters then would have a chance to succeed then his platform in future competitions, mainly because of the large costs of service, training and repair base, which forms a very significant asset life-cycle costs in this project.
Although the economic parameters of any military systems for the acquisition and management of Life Cycle Cost are important, represent only partial access to the decision-making process. Other parameters, particularly technical and combat, of course, are assessed and may be given stronger relevance. An integral part of the decision-making process must be also the risk analysis. On the other hand, an estimate of the Life Cycle Cost is an important input for medium and long term planning. Due to the limited military budget may prove advantageous variant that is needed in higher overall costs, but the favourable timing. It is clear that not only the results of this tender, in addition to economic factors, can affect many other factors (political, diplomatic, military, ...) which in effect may play a crucial role and may modify the final decision.
These factors, however, are not the subject of research, but this article focuses on modelling the exact, quantifiable factors in two LCC phases, utilization and support, and finds system dynamics as a proper method. The process of LCC estimate is generally described and documented and the Czech Republic adopted and implemented appropriate standardization documents, but development of specific models is necessary to support the decision making processes at all phases of the life cycle. The ambition of the article was to contribute to it with a model which can support the comparison of economic factors of considered variants.

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