

Jiří RYBÁŘ¹

PHILOSOPHY OF LIFE CYCLE COSTS CALCULATION IN RAIL VEHICLES

Summary. Life Cycle Costs (LCC) issues have been in awareness of world's leading producers for more than 20 years. Trends of railway vehicle producers worldwide, is to reduce financial costs related to railway vehicles. However, trying to deal with reducing acquisition costs of railway vehicle only would be "short-sighted" and not too competitive. Therefore it is important to deal with LCC problems, which calculate costs join with vehicle during its whole operating live.

FILOZOFIA LCC (LIFE CYCLE COSTS) POJAZDÓW SZYNOWYCH

Słreszczenie. Problematyka LCC jest znana wśród producentów pojazdów szynowych już ponad 20 lat. Ogólnoświatowym trendem jest osiągnięcie jak najniższych kosztów pojazdów szynowych. Nie można jednak brać pod uwagę tylko zmniejszania się kosztów zakupu pojazdu, ale także koszty eksploatacji przez cały czas użytkowania, których obliczenie ułatwia stosowanie LCC.

1. INTRODUCTION

Life Cycle Costs (LCC) issues have been in awareness of world's leading producers for more than 20 years. Trends of railway vehicle producers worldwide, is to reduce financial costs related to railway vehicles. However, trying to deal with reducing acquisition costs of railway vehicle only would be "short-sighted" and not too competitive. Acquisition costs represent only a one part of many costs related to railway vehicle. It's undoubtedly true, that amount of acquisition costs is not inconsiderable, but it's important to focus in other costs. These are in particular maintenance costs and operating costs. Following figure (1.1) presents general costs allocation:

¹ Ing. Jiří Rybář, Institute of Transport, VŠB-TU Ostrava, ul. 17. listopadu 15, 70833 Ostrava, +420 596 995 333, jiri.rybar@email.cz

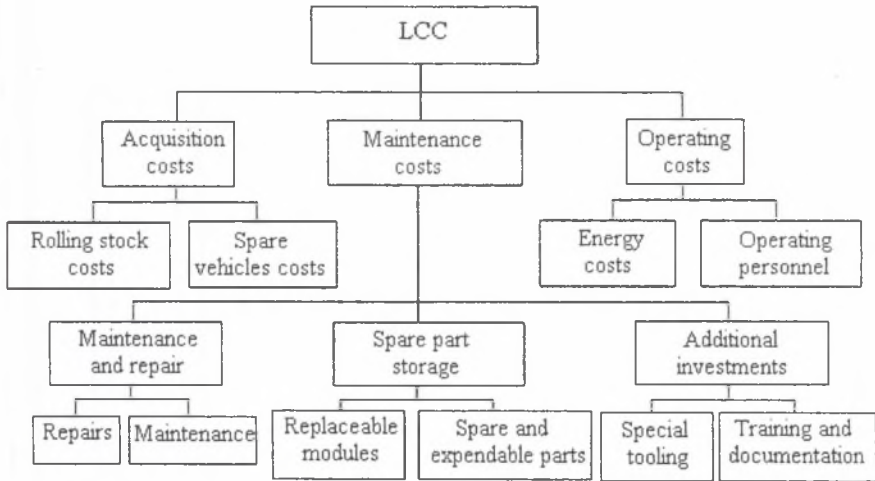


Fig. 1. Structure Life Cycle Costs
Rys. 1. Struktura Life Cycle Costs

All particular cost elements must be defined to calculate total Life cycle costs. The most considering LCC model takes into account acquisition costs, maintenance costs, operating costs and other important railway vehicle owner costs (e.g. training, documentation, education...).

Operating costs are primarily comprised by energy costs related to essential vehicle operation. Other indispensable costs are personnel costs. They are including costs arising from demanding ness of daily attendance needs whether for operation or maintenance. It's important to take into account also spare vehicle costs as special costs, e.g. in case of non-serviceability.

Maintenance costs are calculated out of selected preventive maintenance cycles and also of corrective maintenance data. In LCC model is preventive maintenance cycle defined for each operation activity.

2. LCC CALCULATION PHILOSOPHY

International union of railway vehicle producers UNIFE (Union of European Railway Industries) established working group to answer questions of LCC, reliability, availability, maintainability and safety (RAMS). This group consists of representatives of European railways and supply industries. It aims at common understanding of definitions in LCC problems for each party in the field of railway traffic.

Each group created one volume of UNIFE LCC directive as follows:

- | | |
|------------|---|
| Volume I | Terms and definitions for rolling stock |
| Volume II | Terms and definitions for complex railway systems |
| Volume III | LCC software model interface |
| Volume IV | Data field validation and assessment |

The most interesting for us will be Volume III that describes LCC model created in MS Excel environment.

3. LCC MODULE DESCRIPTION

Module consists of two basic components – MS Excel modules, namely Unidata.xls and Unilife.xls. There are necessary data for LCC costs characteristics calculating being collected in these files. This calculation is accomplished in Unilife module. It's important to examine some further *pdf* format instruction book, that have been created but just for the module, for understanding and proper filling in the MS Excel modules.

Module Unilife itself consists of separate spreadsheets where all important data for proper LCC calculation are entered into. Figure 2 shows one of the Unilife spreadsheet (Global data list), where needed data are exemplified.

Respective LCC calculation simulation, based on Unidata module data entered, is carried out in Unilife module.

4. LCC CALCULATION APPLICATION IN UNIFE MODULE

As it was mentioned before, the Unife module consists of two basic files. Namely Unidata and Unilife file. We can calculate Life Cycle Costs of examined object (e.g. rail vehicle, or partial parts of rail vehicle) by entering necessary data into these files. Unilife and Unidata files imply following spreadsheets:

- Global data.
- Equipment data, CM (corrective maintenance).
- PM (preventive maintenance).
- Maintenance Equipment.
- Error list.
- Miscellaneous costs (Unilife file only).
- LCC Results (Unilife file only).

5. IMPORTANT TERMS AND PREMISES FOR UNIFE MODULE APPLICATION

It's important to realize what the considered lifetime of examined object is while entering data needed for LCC calculation. Therefore a team should be grouped consisting of experts who have necessary experiences and can determine entered data (e.g. lifetime, mileage of considered rail vehicle etc.) as accurate as possible. For even minor deviation from real value (e.g. in year mileage) can result in significant difference in lifetime mileage calculation (e.g. 400 km (c.248 miles) deviation in year mileage can result in up to 10000 km (c. 6200 miles) deviation from real lifetime mileage of rail vehicles. This may result in inclusion false lifetime maintenance costs to calculation, etc.).

UNIFE-UNILIFE

Revision 0

Global data

Project: UNIFE test proj
 Sub-syst. Supplier: Example: Electric co.
 Equipment: UNIFE test system

Parameter	Value	Unit, comments
Personnel Costs		
Original manhour cost	35	Cost
Manhour cost unit	DEM/h	Unit
Life cycle and economy		
Number of trains/plants/lines	15	
Operating distance	320 000	km/y
Discount rate (interest rate - inflation)	4%	Percentage
Life Cycle length (used in calcs)	25	Years
Product Life Cycle (for info only)		Years
Present value factor (calculated)	15,62	
Covered distance during life (calculated)	8 000 000	km
Revenue operating time per year		h (not incl in calcs)
Powered time per year this system	4 000	h (used in calcs)
Remarks: other syst with powered time (h)		

Failure categories

Failure category number	Code	Description
1	Stf	Example: Stopping fault >10 min
2	UWV	Example: Unpl Workshop visit
3	The rest	Example: The rest
4		
5		
6		
7		
8		
9		
10		

Fig. 2. Example of Unilife module spreadsheet

Rys. 2. Przykład karty obliczeniowej dla modułu Unilife

In order to enter preventive maintenance data (PM), it's necessary real system of preventive maintenance execution to be suggested. Nevertheless in order the system to be suggested, we need to have at disposal warranted availability data of single parts of examined rail vehicle, not only rail vehicle itself, but also its groups and single aggregates. We need to determine exact interval and kind of applied maintenance intervention on these aggregates and groups.

Expected corrective maintenance (CM) requires knowledge of certain indicators of reliability. One of them is expected failure rate. This value significantly affects final amount of corrective maintenance costs. Unilife file gives an advantage to implicate locality, where corrective maintenance works are performed. It's common on practice that repairs of some components (traction motor for example) are not performed in rail vehicle depot, but somewhere else (for example in repair shop allocated in other operation, that uses different man-hour calculation) and in many cases are repairs provided by sub suppliers.

There are included also tooling and equipment costs of all maintenance places, whether depots or repair workshops in the LCC results.

Unilife file differentiates with Unidata file through "Miscellaneous costs" and "LCC Results" worksheets.

In the “Miscellaneous costs” spreadsheet are included various costs related to both acquisition and maintenance costs. The spreadsheet includes additional costs (e.g. on documentation, training), energy costs, acquisition costs and so on.

UNIFE-UNILIFE

Revision 0

Project: UNIFE test proj

Sub-syst. Supplier: Example: Electric co.

LCC Calculation Result

Equipment: UNIFE test system

Revision Date 10.12.2000

Global data	Value	Unit
Original manhour cost	35	DEM/h
Number of trains/plants/lines	15	No
Mean production	320 000	km/y
Discount rate	4%	Percentage
Life cycle	25	years
Revenue operating time (info	0	h
Operating time this system	4 000	h
Covered dist during life	8 000 000	km
PM Type	Source data PM	

Investments	Value	Unit
Acquisition Cost	5 000 000	DEM
Maintenance equipment	0	DEM
Spare parts	50 000	DEM
Training	2 000	DEM
Documentation	2 000	DEM
Misc. Inv 1	0	DEM
Misc. Inv 2	0	DEM
Sum Investments	5 054 000	DEM

Yearly costs	Total cost	Discounted cost	Unit
Spec on Misc worksh	62 500	39 055	DEM
Sum yearly costs	62 500	39 055	DEM

LSC (all trains)	Total cost	Discounted cost	Unit
Energy cost	100 000	62 488	DEM
PM	37 973	23 728	DEM
CM	30 120	18 821	DEM
Failure penalty	12 000	7 499	DEM
Sum LSC	180 093	112 537	DEM

Sum LCC (all trains)	5 298 593	5 205 592	DEM
----------------------	-----------	-----------	-----

Fig. 3. Results of Life Cycle Costs model

Rys. 3. Wyniki LCC modelu

Whole LCC calculation in UNIFE module is resulting in “LCC Results” spreadsheet. Part of this sheet is presented at Fig. 1.3. There are introduced costs (e.g. energy absorption demands of operation) related to vehicle operation in the LCC results. Scheduled are also resulting maintenance costs both preventive and corrective.

All misunderstandings between data entered and program functions can be checked up in the Error list worksheet. Error list controls logical sequencing and data relationship.

6. CONCLUSION

The UNIFE organisation redounded by publication of some information to qualitative jump in understanding of some instruments in practical utilisation of LCC philosophy by both producers and rail vehicle users. LCC - Life Cycle Costs issues are considered as important aspect in decision making process in rail vehicle purchase. With Life Cycle Costs knowledge can be in tender chosen vehicle with the lowest lifetime costs.

The UNIFE program is able to feasibly calculate vehicle's Life Cycle Costs, however is unable to distinguish credibility of entered data. That's why is important – as noted previously– so that team of experts whose presumption would stand at experience would cooperate in entering data into the program, thereby these would be the most applicable for the program.

References

1. Daněk A., Kůdela T., Rybář J. Sobek L.: Opravárenství kolejových vozidel, VŠB-TU Ostrava, Ostrava 2004.
2. Internet www.unife.org

Recenzent: Prof. dr hab.inž. Andrzej Wilk