MCA/CEA technological options analysis for GSM-R investment in Poland

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Agenda

1) CEA basics
2) GSM-R Poland case study background
3) Multi-Criteria Analysis to pre-select technological solutions
4) Cost-Effectiveness Analysis to select final option
5) Conclusions

Economic Analysis – CEA basics

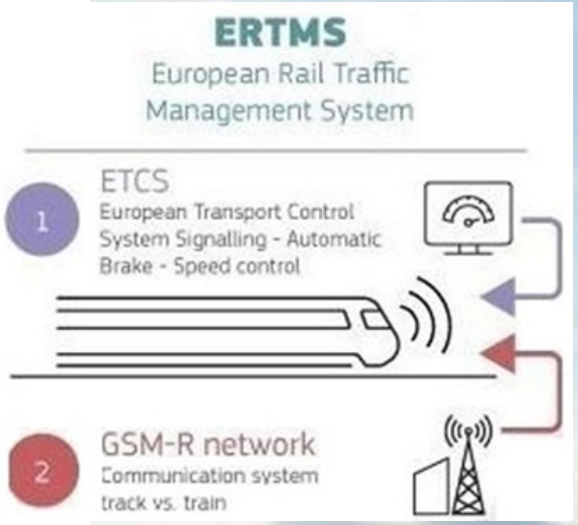
CEA is a practical tool for project option comparison when following conditions apply:

1) *We can safely assume that all options considered are technically and economically viable and/or the project is driven by legislative compliance*
2) *Benefits are difficult or impractical to monetize and there are no externalities*
3) *The project produces only one output that is homogeneous and easily measurable*
4) *The aim is to achieve the output at minimal unit cost*
5) *Life-cycle costs can be completely assessed for each option*
6) *There is a wide range of benchmarks to verify that the chosen option meets the minimum cost performance requirements*

If output volume is identical across options, CEA can be simplified to

Least life-cycle costs analysis (LCA)

ERTMS system



- ✓ **ERTMS** = ETCS + GSM-R = European Railway Traffic Management System
- ✓ **ETCS** = European Train Control System, signalling and control component of the ERTMS
- ✓ **GSM-R** = GSM digital standard telecom system for Railways
- ✓ BTS = Base Transceiver Stations
- ✓ BSC = Base Station Controller
- ✓ BSS = Base Station Subsystem = BTS + BSC
- ✓ **ETCS Level 1** (v) **ETCS Level 2**

Poland GSM-R Case Study Background

- Polish railway network of approx. **15,400** km
- **Existing** analogue train radio VHF system (analog), covering 95 % of the railway network, was built over 40 years ago
- GSM-R is a key component of the **mandatory** ERTMS system to be implemented on the TEN-T network by 2030 (to ensure international interoperability)
- **1,587** km of track already equipped with GSM-R by end of 2017
- Scope of GSM-R implementation of **13,844 km** going well beyond TEN-T network – strategic decision on unified national system not subject of this presentation
- CEA performed for further options analysis as allowed/required by ESIF CBA legislation for compliance projects as CBA substitute in 2014-2020 funding period

Technological Options

- Assessment performed by Polish PKP-PLK railway administration and their consultants with the support of JASPERS :
  - ✓ MCA (short-listing to find suitable solutions) followed by
  - ✓ CEA (final selection to ensure cost-effective choice)
- Technological options based on various levels of redundancy of the base station system, which impact **reliability/integrity** of ETCS
- **4 options** were developed with identical network coverage :

W1: (**highest** integrity) double coverage on whole GSM-R network, both BTS and BSC
W2: (**medium** integrity) single coverage of BTS & double coverage of BSC
W3: (**low** integrity) single coverage of BTS and BSC
W4: (**mixed**) W1 on lines to be fitted with ETCS level 2 system & W2 on rest of network

Technological Option Analysis - MCA preselection

Two main criteria for the MCA with equal weight:

1) **Quality/reliability** of the technical solution in relation to operational needs

2) **Whole life** investment and operations/maintenance **costs** of the solution

Technological Option Analysis - MCA (1)

1) **Quality/reliability** of the technical solution in relation to operational needs

OPTIONS	W1	W2	W3	W4
Strength - Advantages				
Full compatibility with the GSM-R standard	8	8	8	8
High availability of the GSM-R system (key for ETCS)	8	4	2	8
Limited technical complexity of GSM-R configuration	4	4	8	4
Uninterrupted transfer of driving permits in the ETCS system	8	4	2	8
Weaknesses - Disadvantages				
Sensitivity to internal damage	-2	-2	-8	-2
Sensitivity to peripheral and external device damage	-2	-2	-8	-2
Maintenance susceptibility of GSM-R configuration	-2	-2	-8	-2
Time to restore full system effectivness	-2	-4	-4	-4
Opportunities				
Use data transmission for other purposes, related to activities of rail network manager	2	2	2	2
Threats				
Interference from other wireless communicatoin systems	-2	-2	-2	-2
Total score	**20**	**10**	**-8**	**18**
Total score (with 0 as minimum)	**28**	**18**	**0**	**26**

Technological Option Analysis - MCA (2)

2) Whole life investment and operations/maintenance costs of the solution

INVESTMENT COSTS	Unit cost ('000 EUR)	Option length (km)			
		W1	W2	W3	W4
Double coverage BTS/BSC	23	13 844	-	-	3 013
Single coverage BTS/Double coverage BSC	14	-	13 844	-	10 831
Single coverage BTS/BSC	12	-	-	13 844	-
Optic cables	16	10 963	10 963	10 963	10 963
Other fixed costs for GSM-R system	90 983				

O&M COSTS	
Maintenance: double coverage: EUR/km/year	917
Maintenance: single coverage: EUR/km/year	785
Operations costs % of investment costs/year	0,1%

Technological Option Analysis - MCA (3)

OUTCOME OF MCA OPTIONS ANALYSIS	W1	W2	W3	W4
Investment costs (m EUR)	577	453	429	480
Discounted lifetime operations costs (m EUR)	180	153	153	159
Whole life costs total (m EUR)	757	606	582	639
Technical quality of solution: adjusted score	28	18	0	26
Cost score (10 = best option, weight 50 %)	3,8	4,8	5	4,6
Technical quality score (10 = best option, weight 50 %)	5	3,2	0	4,6
Total Score	**8,8**	**8**	**5**	**9,2**

Interpretation of MCA Score Outcome

- ✓ W3 cheapest but with inadequate technical performance, while not much cheaper than W4
- ✓ W2 cheapest technically plausible option but similar in cost to W4, which is much better technically
- ✓ **Short-listing of options W1 and W4, which have comparable/sufficient fitness for purpose**

Economic Analysis – Qualification of GSM-R for CEA

1. One identifiable measurable project output = km of implementation
2. Crucial element of compliance with EU legislation & benefits difficult to estimate
3. Aim to achieve output at minimum unit cost (after comparable, fit for purpose solutions have been pre-selected)
4. Evidence of appropriate benchmarks benchmarks supporting the project :

   ✓ Polish tendered GSM-R investment costs (W4) ~ 40 thousand EUR / km

   ✓ Typical cost range in other countries ~ circa 50-100 thousand EUR / km

Economic Analysis – CEA for GSM-R

Concluding CEA performed for shortlisted options W1 and W4

- Chosen CEA indicator = Lifecycle cost / km / year
- Discount rate of 4 %
- Investment / operations costs as in MCA
- Evaluation period of 24 years from 2024

CEA Result

✓ W1: 3.8 thousand EUR / km / year

✓ **W4: 3.2 thousand EUR / km / year**

As the Output size is identical for both options,

LCA would have been sufficient, which was already an MCA criteria

Conclusions for transport sector compliance projects

a) Where full CBA cannot be performed, wide benchmarking of unit costs should be carried out in any case to root the final decision in market experience

b) MCA can be used as a tool to ensure that sufficiently fit-for-purpose options are pre-selected for final CEA/LCA decisions

c) CEA/LCA are suitable for legislative compliance projects to assess alternatives, which are sufficiently fit for purpose

   - Where technological options have the same output, LCA is the appropriate tool

d) If life-cycle cost is included in an MCA, the LCA outcome will already be apparent for short-listed options

e) No formal MCA/CEA/LCA requirements for ESIF or CEF funding, however each MS needs to have a robust EA system to justify investment decisions

More Information

For info or further questions on this webinar please contact the JASPERS Networking Platform team:

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