

*ERTMS, ETCS, SRK, estimated cost,
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ESTIMATED COSTS OF IMPLEMENTATION ERTMS/ETCS FOR THE SECTION OF KATOWICE – WISŁA BRIDGE - ZWARDON RAILWAY LINE

Estimated cost of ERTMS/ETCS system development for levels 1 and 2 for the proposed railway line section has been presented in this article. Calculations have been carried out on the basis of the existing railway traffic control appliances conditions and the general outline of the new system development. An analysis of undertaking effectiveness for level 2 and an analysis of susceptibility, that is the influence of financial flows variability on change of value regarding valuation of system implementation indicators have been carried out in compliance with the World Bank methodology.

SZACUNKOWE KOSZTY WDROŻENIA SYSTEMU ERTMS/ETCS DLA ODCINKA LINII KATOWICE - MOST WISŁA-ZWARDOŃ

W artykule przedstawiono szacunkowy koszt zabudowy systemu ERTMS/ETCS dla poziomu 1 i 2 proponowanego odcinka linii. Obliczeń dokonano w oparciu o stan istniejący urządzeń sterowania ruchem kolejowym oraz koncepcję zabudowy nowego systemu. Stosując metodykę Banku Światowego przeprowadzono analizę efektywności przedsięwzięcia (dla poziomu 2) oraz analizę wrażliwości, czyli wpływu zmienności strumieni finansowych na zmianę wartości wskaźników oceny wdrożenia systemu.

1. INTRODUCTION

The existing European railway lines equipment is really variable both in range of signaling and of appliances transmitting information from lines to vehicles. It makes unification of rail operation difficult. The European Rail Transport Management System (ERTMS) complies with the European Union pursuit to create the uniform European transport system ensuring interoperation that is compliance of facilities, power supply, appliances control, rail operation rules and rolling-stock. According to European Union legal regulations,

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it often occurs that interoperation concerns not only brand - new railway lines but also the existing ones e.g. those modernized and being incorporated into Trans-European Rail System.

Legal conditions of ERTMS implementation.

Among legal conditions of ERTMS implementation for “Polish State Railways” the following European Union legal acts should be mentioned:

- Directive UE 2001/16/EC of 19 March 2001 “On interoperability of Trans-European conventional railway system”
- Directive UE 96/48/EC of 23 July 1996 “On interoperability of Trans-European high speed railway systems”

And also the supplementary Directive UE 96/48/EC by decision:

- 2001/260/EC of 21 March 2001 „ On the basic parameters of the control system” establishing ERTMS/ETCS and ERTMS/GSM-R specification

replaced :

- by decision 2002/731 of 30 March 2002 „ On technical specification for interoperating within control subsystem of Trans-European high speed railway systems”.

In 2004 the following legal acts became valid:

- Directive 2004/50/EC „On interoperability of railway systems”;
- Decision 2004/447/EC.

Directive 2004/50/EC of 29 April 2004 amends:

- Directive 96/48/EC “On interoperability of Trans-European high speed railway system”
- Directive 2001/16/EC “On interoperability of Trans-European conventional railway system”

Decision 2004/447/EC of 29 April 2004 altering an appendix A to Decision 2002/731/EC of 30 May 2002 establishing basic characteristics of A category system (ERTMS), subsystem of control of Trans – European conventional railway system defined in Directive 2001/16/EC and defines the control subsystem both for high speed railways and for conventional railways. It is the direct consequence of the statement that high speed trains equipped with ERTMS as well as conventional trains should have the possibility of undisturbed locomotive faculty within conventional railways (equipped with that system).

2. THE ERTMS INSTALLATION ON THE SECTION OF KATOWICE – ZWARDON RAILWAY LINE

Katowice - Wisla Bridge – Zwardon railway line discussed hereby is the general outline of the new ERTMS/ETCS system development on the basis of the existing railway traffic control appliances and the existing rail radio-communication.



Fig.1. Proposed section Katowice – Wisla Bridge – Zwardon

ERTMS system implementation influences stationary and lineal srk systems as well as remote control system. Range of their impact depends on the ETCS level and configuration of trackside appliances used to information exchange.

2.1. INSTALLATION COST

Estimated cost of system development for level one Katowice - Wisla Bridge – Zwardon railway line concerning the proposed number of balis, LEO coders, euro-loop lines and ETCS appliances on the vehicle is going to amount to over EUR 13,500.

For the level 2 reconstruction of the existing stationary appliances into electronic ones placed inside six remote control centers located in the following stations: Katowice, Katowice-Ligota, Tychy, Czechowice-Dziedzice, Bielsko-Biala, Zywiec is required. Sequence of trains management within the section under discussion is being accomplished considerably by new automatic block system - model Eap. There is no necessity of replacement. It is only necessary to build in spaces missing in the Eap appliance. It is possible that railway passage protection by means of Radio Broadcasting Centers (RBC) functions will be considered (level 2). Section Katowice – Polish State Railways border is equipped with an analogue system of radio-communication operating within the 160MHz band which should be replaced with GSM-R system operating within the 900MHz band. The estimated cost regarding development of new appliances, given number of balis, two RBC and ETCS appliances on the vehicle for that level will amount to over EUR 140,000. Accurate calculation is shown in the tables 1 and 2.

Table 1

Estimated cost of ERTMS/ETCS appliances development for level 1

No.	Appliance name	Unit price (EUR)	Number of appliances	Total cost (EUR)
1.	Balis	1 523	422	642 706
2.	LEU coder	25 280/km	113,785 km	287 648
3.	Euro-loop line	10 718	30	321 540
4.	ETCS on vehicle	81 915	150	12 287 250
Total cost for Katowice – Polish State Railways border section				13 539 144

Table 2

Estimated cost of ERTMS/ETCS appliances development for level 2

No.	Appliance name	Unit price (EUR)	Number of appliances	Total cost (EUR)
1.	Remote control			82 242 250
2.	Balis	1 523	168	255 864
3.	RBC	5 888 000	2	11 776 000
4.	ETCS on vehicle	263 315	150	39 497 250
5.	GSM-R	55 000/km	113,785 km	6 258 175
Total cost for Katowice – Polish State Railways border section				140 029 530

2.2. VALUATION OF INVESTMENT EFFECTIVENESS

Having calculated cost of ERTMS appliances development for discussed section of 139 Katowice – Zwardon railway line level 2, valuation of effectiveness for that undertaking has been carried out (Expences and profits for the task have been estimated).

The World Bank method which indicates two kinds of the investments effectiveness valuation: financial and economic ones, has been applied. Financial valuation considers investing company's interests that is of Polish State Railways and is based on net results settlement of the task. Financial valuation results inform about possible return of capital expenditures born in the undertaking. Economic valuation considers general economic point of view and informs whether the investments benefits in terms of general economy or not.

Calculation of investment effectiveness is composed of specification including investment outlays, operating costs, income and measurable direct and indirect costs whereafter calculation of valuation indicators value on that basis.

Profit is the criterion of investment effectiveness in the assumed method and basic investment valuation indicators are as follows:

NPV – Net Present Value – updated net value of the undertaking

IRR – Internal Rate of Return – Internal rate of capital return.

B/C Ratio – Benefis - Cost Ratio – Outlay and cost effectiveness indicator

PP – Playback Period – indicator determining period of investment capital return.

The above specified indicators for the task ERTMS development are as follows:

NPV amounts to - 177 472 674

IRR amounts to - 28.59%

B/C - 2.56

PP - 5 years.

NPV = 177 472 674 is positive number and show considerable effectiveness of undertaking that is its earning capacity. IRR = 28.59 determines actual rate of return which is above satisfactory. Provided that B/C ratio is above 1, the undertaking is profitable. It amounts to 2.56 herein. PP = 5 years indicator is supplementary in relation to the above mentioned ones. It guaranties financial outlays return after 5 years. Detailed data is shown in table 4.

2.3. AN ANALYSIS OF THE INVESTMENT SUSCEPTIBILITY

An analysis of susceptibility has also been carried out. Its aim is to indicate the influence of financial flows variability regarding particular components of investment outlays, operating costs and transport services receipts and the influences of transport services on change of value regarding undertaking valuation indicators. The task is more susceptible to decrease in profits resulting from system development than to investment outlays increase. 20% decrease in profits results in 5.63% decrease in IRR whereas 20% increase in outlays reduces IRR indicator by 2.25%. The conclusion is that particular attention should be paid to profits resulting from the new system implementation.

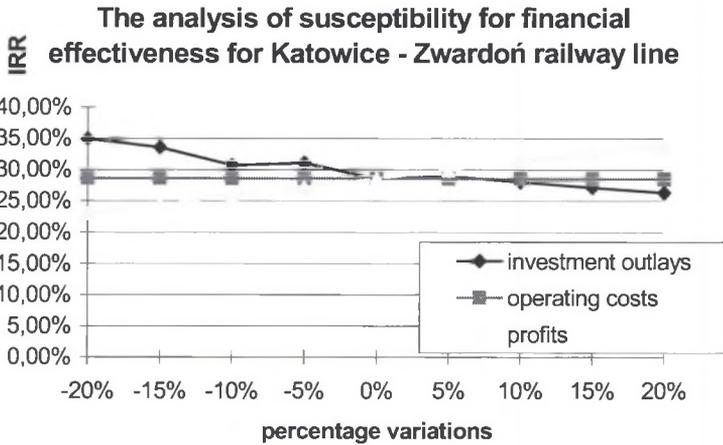
The above calculations are presented in table 3 and on the graph showing susceptibility analysis – financial effectiveness.

Table 3

Results the analysis of susceptibility – financial effectiveness of ERTMS appliance development on 139 Katowice – Zwardon railway line

IRR VALUES FOR FINANCIAL FLOWS VARIATIONS

Scale flow variations	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Investment outlays	34,97%	33,56%	30,70%	31,09%	28,59%	28,98%	28,04%	27,12%	26,34%
Operating costs	28,69%	28,67%	28,64%	28,62%	28,59%	28,57%	28,54%	28,48%	28,49%
Profits	22,96%	24,39%	25,81%	27,21%	28,59%	29,96%	31,31%	32,64%	33,98%



3. CONCLUSION

In conclusion ERTMS/ETCS level 2 system development within the proposed section will ensure prospective savings. Operating costs concerning the existing appliances will be reduced by means of: staff reduction, stations liquidations, power loss reduction (stopping and starting at limited speed). Railway lines capacity will be higher and working conditions as well as the quality of railway transport services and travel comfort. Outlay costs born in connection with the task implementation will be returned after 5 years, making the investment profitable. Its prospective earning capacity is high enough to bring loss regarding operating of the section if fulfilled.

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Table 4

FINANCIAL EFFECTIVENESS OF ERTMS APPLIANCES DEVELOPMENT FOR KATOWICE - ZWARDON RAILWAY LINE.

Year	EUR												
	Investment outlays	Maintenance costs	Total costs	Profits				Transport receipts	Total profits	Net profits	Discounted Net Profits	Return period	Discounted Return Period
				Savings within employment	Light pipe lease cost	Savings within traction energy	Savings within maintenance costs						
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	28 029 530	949 582	28 979 112		290 515				290 515	-28 688 597	-26 080 543	-28 688 597	-26 080 543
2	28 000 000	949 582	28 949 582		290 515				290 515	-28 659 067	-23 685 179	-27 347 604	-49 765 722
3	28 000 000	949 582	28 949 582	1 145 300	290 515	18 172 000			19 607 815	-9 341 767	-7 018 608	-6 689 431	-56 784 330
4	28 000 000	949 582	28 949 582	1 145 300	290 515	18 172 000			19 607 815	-9 341 767	-6 380 553	-76 031 198	-63 164 882
5	28 000 000	949 582	28 949 582	1 145 300	290 515	18 172 000		24 002 000	43 609 815	14 620 233	9 102 851	-61 370 965	-54 062 031
6		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	23 723 618	17 571 568	-29 338 413
7		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	22 476 016	26 227 829	-6 862 397
8		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	20 432 742	70 027 226	13 570 345
9		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	18 575 220	113 826 623	32 145 565
10		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	16 886 564	157 626 020	49 032 128
11		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	15 351 421	201 425 417	64 383 550
12		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	13 955 838	245 224 814	78 339 387
13		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	12 687 125	239 024 211	91 026 513
14		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	11 533 750	332 823 608	102 560 263
15		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	10 485 227	376 623 005	113 045 490
16		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	9 532 025	420 422 402	122 577 515
17		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	8 665 477	464 221 799	131 242 992
18		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	7 877 707	508 021 196	139 120 699
19		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	7 161 551	551 820 593	146 282 250
20		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	6 510 501	595 619 990	152 792 751
21		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	5 918 638	639 419 387	158 711 389
22		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	5 380 580	683 218 784	164 091 969
23		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	4 891 436	727 018 181	168 983 404
24		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	4 446 760	770 817 578	173 430 164
25		760 000	760 000	1 145 300	290 515	18 172 000	949 582	24 002 000	44 559 397	43 799 397	4 042 509	814 616 975	177 472 674
Σ	140 029 530									177 472 674	B/C Ratio	2,56	
										28,59%	PP	5 years	
											NPV		
											IRR		
											discount rate =	10,0%	