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CONTRACTED PRICE OVERRUN AS CONTRACTED CONSTRUCTION TIME OVERRUN FUNCTION

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Original scientific paper

By establishing the model for the quick estimation of the construction time in contracted price function and the construction time overrun model in risk factor function, a logical question arises what effect this has on the contracted price when applying such models in practice. This paper analyses the procedure for establishing a model for building construction structures – new construction. This model expresses the contracted price overrun in relation to the construction time overrun caused by risk factors. The model is in the form of exponential equation whose basic advantage is its form of a natural logarithm. The logarithm transformation enables the use of a single linear regression for determining the model parameters. It is appropriate for the early planning stage under the conditions when there is a real possibility of risk factor occurrence. Due to economic differences, its application is recommended for regions where the research was conducted.

Key words: *construction, contracted price, contracted time, overrun function*

Prekoračenje ugovorene cijene kao funkcija prekoračenja ugovorenog vremena građenja

Izvorni znanstveni članak

Uspostavom modela za brzu procjenu vremena građenja u funkciji ugovorene cijene i modela za prekoračenje vremena u funkciji rizičnih faktora, nameće se logično pitanje što se događa s ugovorenom cijenom građenja primjenom tih modela u praksi. U ovom se radu prikazuje metodološki postupak uspostave modela za objekte visokogradnje kojim se iskazuje prekoračenje ugovorene cijene u ovisnosti od prekoračenja vremena građenja uslijed djelovanja rizičnih faktora. Pretpostavljeni model je u formi eksponencijalne jednadžbe, što je i njegova temeljna prednost. Logaritamska transformacija omogućava primjenu jednostruke linearne regresije za određivanje parametara modela. Model je prikladan za ranu fazu planiranja u uvjetima u kojima postoji realna mogućnost pojave rizičnih faktora. Zbog gospodarskih i drugih razlika njegova je primjena ograničena samo na područje istraživanja.

Ključne riječi: *funkcija prekoračenja, građenje, ugovorena cijena, ugovoreno vrijeme*

1 Introduction
Uvod

The contracted construction date overrun and the contracted construction price overrun issues are distinct in construction practice. This thesis is confirmed by the numerous scientific analyses. The World Bank report [1] points out the average of 70 % overrun in 88 % out of 1627 projects as well as an average of 40 % anticipated price overrun in 63 % out of 1778 financed construction projects. Unfortunately, the experience of the developing countries and the transition countries are not at least more positive.

A multiannual research of due date and cost overruns which was conducted in Croatia from 1996 till 1998 as part of the scientific project Construction Project Risk and Resource Management [2] pointed out the occurrence of due date overrun in 78 % out of 333 analysed projects and the occurrence of price overrun in no less than 81 % projects. As part of the mentioned research, the structure of date and price overrun reasons was analysed. According to demands, those risks were positioned at several levels (e.g., the highest level being the division on internal and external risks, taking into consideration whether they occur within the project system or in its surroundings).

The research was conducted on a sample of 92 traffic structures built in Slovenia from 1993 till 1998 and indicates an average of 63 % of date overrun and 51 % of contracted construction price overrun [3]. This paper also analyses the risks which caused the price overrun in the project completion stage.

A similar research was conducted in Bosnia and Herzegovina on 177 structures built from 1995 till 2006. The results indicated that the contracted date was not met in 51,40 % of structures and the contracted price was not met in 41,23 % of structures [4].

One of the reasons for overrunning the contracted dates and prices is definitely the absence of a thorough expert analysis of conditions, circumstances and possible risks when concluding a contract. Therefore the due date is more often the result of the client's wish rather than of the contractor's objective capacities.

Taking into consideration that the construction is a business of a design type, which means a complex and demanding one, it is very important to conduct the preparation and the planning stage well. Two levels of planning must be pointed out:

- planning of the construction time under usual risk level conditions and
- planning of the construction time under expected increased risk conditions.

The scientific research which was conducted on 29 constructed building construction objects – new construction – in Federation of Bosnia and Herzegovina resulted in establishing two models for a quick construction time estimation [4, 5]:

1. the model for conditions under which no risk factor influence is expected and which is expressed solely in relation to the contracted price, the so called "time-cost" model:

$$T = 70 \cdot C^{0,52} \tag{1}$$

where:
T - the construction time in days,
C - the construction price expressed in 100 000 KM (convertible mark – BiH currency, KM = BAM, 1 EUR = 1,9568 BAM).

The "time-cost" model, whose aim is to estimate the construction time as accurately as possible already at early project stages, was established by the Australian scientist Bromilow in the 1960s. Since this model was determined as the construction price function, its applicability only to the research part is quite understandable. After the first research the credibility of the model was later confirmed on several occasions also in Great Britain, China, Texas, Malesia, Croatia etc. [6, 7, 8, 9].

The confirmation of "time-cost" model credibility in Bosnia and Herzegovina is actually the first scientific research [4] from the field of construction time planning which has ever been conducted in this transition country.

A total of 177 structures, classified into seven groups, were analyzed. This paper discusses only one group, the building construction structures – new construction.

2. the model for conditions under which there is a real expectancy of risk factor occurrence and influence which is expressed as a "time-cost" model sum and the anticipated construction time overrun in days:

$$T_{\text{tot}} = T + \Delta T \tag{2}$$

where:
T_{tot} - the total anticipated construction time,
T - the anticipated construction time according to the "time-cost" model (1),
ΔT - the anticipated construction time overrun due to risk factors.

The establishing of this model was preceded by the methodology of proving the hypothesis that the main risk factors, such as technical documentation (running behind schedule, inaccuracy, incompleteness), natural conditions (climate, soil, underground waters, natural disasters) and legal circumstances (local regulations, consents and permits, changes of law and standards), are of crucial importance so that the total construction time overrun can be expressed in relation to those factors. By applying the multivariant linear regression the model for quick estimation of construction time overrun was established [4].

$$\Delta T = 1{,}749 + 1{,}353 \cdot e + 0{,}896 \cdot g + 0{,}946 \cdot a \tag{3}$$

where:
ΔT - the total construction time overrun percentage
e - the construction time overrun percentage due to the influence of a risk factor – natural conditions
g - the construction time overrun percentage due to the influence of a risk factor – technical documentation
a - the construction time overrun percentage due to the influence of a risk factor – legal circumstances.

The discussed models are applicable in the early planning stage as a substitute for the present practice according to which the construction time is determined at flat-rate based on designer and contractor experience. They are easily applicable in construction practice but due to economic and other differences its applicability is primarily recommended for the region where the research was conducted, that is, in Federation of Bosnia and Herzegovina or possibly in the regions with similar economic characteristics such as post-transition countries of southern and south-eastern Europe. Guidelines for improving the obtained model are proposed.

If there is a real estimation for risk factor occurrence and influence on construction time overrun expressed in contracted price function, a logical sequence of research activities is the "behaviour" of the contracted price under such conditions. Money, that is, profit is definitely one of deciding factors for a contractor's undertaking the job.

2 Research methodology

Metodologija istraživanja

2.1 Data base

Baza podataka

As in previous researches [4, 5] which resulted in the above described models, the same data base was used. The data were obtained for a total of 29 building construction structures – new construction, which were built in Federation of Bosnia and Herzegovina in the period from 1996 till 2006, by using the method of a semi-structured interview with engineers in charge. All the examinees were asked the same questions:

- structure construction year
- contracted construction time T_{C}
- effectuated construction time T_{E}
- contracted construction price C_{C}
- effectuated construction price C_{E}
- reasons for disregard of the due date
- reasons for disregard of the contracted price.

Table 1 shows the field data as well as the basic statistical indicator calculation. From the total of 19 structures, the disregard of the due date was noted at 20 (68,97 %) while both due date and contracted price overruns were noted at 17 structures (58,62 %). The maximum due date overrun is 46,67 % and the maximum contracted price overrun is 29,16 %, while the due date was overrun in average of 11,55 % and the contracted price of 6,84 %.

2.2 Proposed model

Predloženi model

The very essence of the problem is how to estimate the required unknown variables, those being in this case the contracted price overrun, by using the several known ones, that is, to find a theoretical model which would best approximate the relation between the variables. The proposed model [10] is in the form of the exponential equation.

$$\Delta C = K \cdot (\Delta T)^{B} \tag{4}$$

where:
ΔC - the contracted price overrun,
ΔT - the contracted time overrun* due to risk influence (*construction time determined according to the "time-cost" model). The linear form enables the application of a single linear regression which determines the K and B parameter values.

Table 1 *Data base with basic statistical indicators*
Tablica 1. *Baza podataka s osnovnim statističkim pokazateljima*

Structure	Year of constr.	Time of constr. in days			Construction price, KM			Overruns, %	
		T_C	T_E	$\Delta T^{(1)}$	C_C	C_E	$\Delta C^{(2)}$	ΔT	ΔC
1	2	3	4	5	6	7	8	9	10
1	2003.	180	255	75	2 200 012,58	2.644 706,31	444 693,73	41,67	20,21
2	2002.	120	130	10	256 163,15	281 779,46	25 616,31	8,34	10,00
3	2003.	360	412	52	149 972,90	159 472,90	9 500,00	14,44	6,33
4	2004.	60	69	9	171 572,00	184 772,00	13 200,00	15,00	7,69
5	2004.	90	100	10	172 940,00	185 039,54	12 099,54	11,11	7,00
6	2004.	20	18	-2	297 763,60	270 701,64	-27 061,96	-10,00	-9,09
7	2004.	60	68	8	140 529,20	161 159,80	20 630,60	13,33	14,68
8	1998.	510	510	0	700 000,00	700 000,00	0,00	0,00	0,00
9	1998.	30	30	0	26 460,20	26 460,20	0,00	0,00	0,00
10	1996.	150	150	0	221 294,65	221 294,65	0,00	0,00	0,00
11	2001.	180	180	0	713 038,32	713 038,32	0,00	0,00	0,00
12	2005.	60	60	0	155 180,18	155 180,18	0,00	0,00	0,00
13	2006.	90	120	30	300 000,00	313 440,00	13 440,00	33,34	4,48
14	2006.	180	230	50	1 000 000,00	1 110 000,00	110 000,00	27,78	11,00
15	1998.	165	201	36	301 890,00	301 890,00	0,00	21,82	0,00
16	2001.	300	300	0	300 000,00	300 000,00	0,00	0,00	0,00
17	2002.	30	30	0	25 000,00	25 000,00	0,00	0,00	0,00
18	2002.	360	360	0	2 004 264,17	2 004 264,17	0,00	0,00	0,00
19	2003.	150	150	0	1 002 132,08	1 002 132,08	0,00	0,00	0,00
20	2005.	120	135	15	342 007,90	357 212,76	15 204,86	12,50	4,45
21	2003.	150	220	70	635 005,55	735 135,23	100 129,68	46,67	15,77
22	2003.	90	110	20	250 000,00	269 076,34	19 076,34	22,22	7,63
23	2003.	90	95	5	145 309,14	155 309,14	10 000,00	5,56	6,88
24	2003.	210	223	13	60 108,32	74 496,83	14 388,51	6,19	23,94
25	2005.	320	380	60	948 790,00	1 225 534,00	276 744,00	18,76	29,16
26	2003.	60	70	10	153 387,56	173 387,56	20 000,00	16,67	13,04
27	2005.	120	132	12	170 221,78	187 009,78	16 788,00	10,00	9,86
28	2005.	90	100	10	150 000,00	169 835,00	19 835,00	11,11	13,22
29	2002.	60	65	5	405 883,00	414 882,00	8 999,00	8,33	2,22
						Average		11,55	6,84
						Median		10,00	6,33
						Minimum		-10,00	-9,09
						Maximum		46,67	29,16
						1st Quartile		0,00	0,00
						3rd Quartile		16,67	11,00
						Interquartile deviation		16,67	11,00
						Standard deviation		13,30	8,41
						Variance		176,9	70,78

(1) contracted construction time overrun , $\Delta T = T_E - T_C$
(2) contracted price overrun, $\Delta C = C_E - C_C$

K - the model parameter which expresses the required average contracted price overrun for a period of time
B - the model parameter which expresses the price overrun change in dependence on the construction time overrun change.

The main advantage of the proposed model is that it can be expressed in a linear form by using the logarithm transformation:

$$\ln \Delta C = \ln K + B \cdot \ln \Delta T. \tag{5}$$

2.3 Model algorithm
Algoritam modela

The single regression analysis is one of the oldest statistical procedures to be applied when analysing different scientific fields. It represents the mathematical equation which expresses one random variable correlatively linked to the other random variable.

The function is a polynomial of the first grade $y = ax + b$ and is called the regression straight line [11, 12, 13].

- Since the very single linear regression is universal, the issue of creating the way in which the research in question can be reduced to its application follows the following steps [9]:
- prices are to be reassessed by applying the price increase index in relation to the observed period of time, that is, May 2007 [14]
- natural logarithms $\ln\Delta T$ and $\ln\Delta C$ are to be calculated for the obtained field data which relate to the construction time overrun ΔT and the contracted price overrun ΔC which was previously reassessed
- the correlation coefficients R, the determination coefficients R^2, the corrected determination coefficients AR^2 and standard error assessment are to be

determined

- the authentication of the linear dependence between the variables ΔC – ΔT is to be conducted by using the correlation coefficient R and a visual assessment of the diagram x–y
- the regression analysis is to be conducted and the straight line equation of the assessor is to be defined
- the zero hypothesis is to be tested. Should this case prove the zero hypothesis wrong, it means the confirmation of the assumption that the construction price overrun is in function of the construction time overrun for the structure in question
- the confidence intervals are to be determined for the gradient and the section
- the residuals are to be calculated
- the diagram "estimated values – residuals" is to be drawn in order to authenticate the results. The scattered points in the diagram point out the random errors.
- If the model can be assessed as the adequate one, the assessment indicators for the gradient and the section as well as the maximum and minimum values from the 95 % confidence interval are adopted. The parameter values of the models K and B are calculated, where:

$$\ln K = b \quad (6)$$

$$K = \mathrm{e}^{b} \quad (7)$$

$$B = a \quad (8)$$

For calculating the statistical indicators and conducting the single regression analysis the computer program SPSS 9 was used in this paper.

It must be pointed out that there are 9 structures in the data base out of 29 which had no construction time overrun, as well as 2 structures which had no simultaneous time and price overrun and will accordingly be excluded from the analysis. Therefore the following analysis relates to 18 structures only.

Table 2 *Linear regression input data*
Tablica 2. *Ulazni podaci za linearnu regresiju*

Ord. number of the structure	ΔT	$\ln\Delta T$	ΔC	$\ln\Delta C$
1	75	4,31749	413565,17	12,93257
2	10	2,30259	24079,33	10,08911
3	52	3,95124	8835,00	9,08648
4	9	2,19722	12672,00	9,44715
5	10	2,30259	11615,56	9,36010
7	8	2,07944	19805,38	9,89371
13	30	3,40120	13490,00	9,50970
14	50	3,91202	110000,00	11,60824
20	15	2,70805	15204,86	9,62937
21	70	4,24850	93120,60	11,44165
22	20	2,99573	17741,00	9,78363
23	5	1,60944	9300,00	9,13777
24	13	2,56495	13381,31	9,50161
25	60	4,09434	276744,00	12,53085
26	10	2,30259	18600,00	9,83092
27	12	2,48491	16788,00	9,72842
28	10	2,30259	19835,00	9,89520
29	5	1,60944	8459,06	9,04299

2.4 Application of single linear regression on data base
Primjena jednostruke linearne regresije na bazu podataka

After the price reassessment was performed by using the price increase index in relation to the observed period of time, that is, May 2007 [15], the natural construction price overrun and construction time overrun logarithms were calculated. Those are, in fact, the input data for single regression analysis and are shown in Table 2. Where:
ΔT - the contracted time overrun in days
ΔC - the contracted price overrun reassessed by V/07, KM
$\ln\Delta T$ - the natural logarithms for contracted time overruns
$\ln\Delta C$ - the natural logarithms for contracted reassessed price overruns.

Table 3 shows the computer calculation of correlation coefficient, determination coefficient, adjusted determination coefficient, standard error assessment, gradient and section values, that is, the regression indicators of straight line assessor as well as of boundary values of 95 % confidence interval.

Table 3-1 *Results of single regression for the whole sample*
Tablica 3-1. *Rezultati jednostruke regresije za cijeli uzorak*

Model	R	R^2	AR^2	Standard evaluation error
1	0,740(a)	0,547	0,519	0,8131
a Predictors: (free member), $\ln\Delta T$				

Table 3-2 *Results of single regression for the whole sample - ANOVA(b)*
Tablica 3-2. *Rezultati jednostruke regresije za cijeli uzorak - ANOVA (b)*

Model		Square sum	Grade freedom number	Variance	F	Sig.
1	Regional value	12,773	1	12,773	19,320	0,000(a)
	Residual	10,578	16	0,661		
	Total	23,351	17			
a Predictors (free member), $\ln\Delta T$; b Dependent variable: $\ln\Delta C$						

Table 3-3 *Results of single regression for the whole sample - coefficients (a)*
Tablica 3-3. *Rezultati jednostruke regresije za cijeli uzorak - koeficijenti (a)*

Model		Non-standardized coefficients		Standardized coefficients	t	Sig.	95 % reliability interval for B	
		B	Standard error	Beta			Bottom limit	Upper limit
1	Free member	7,395	0,652		11,335	0,000	6,012	8,778
	$\ln\Delta T$	0,960	0,218	0,740	4,395	0,000	0,497	1,423

The diagram of the relation "$\ln\Delta C - \ln\Delta T$" is shown in Figure 1. The y axis bears the values of natural logarithms for contracted revalued price overruns $\ln\Delta C$ while the x axis bears the values of natural logarithms for contracted time overruns $\ln\Delta T$ and their straight line assessor. By visually appraising this diagram it was established that certain structures significantly reduce the linear approximation aptitude.

In order to obtain larger correlation and determination coefficients, the linear regression procedure with a reduced sample was repeated so that the structures under No. 1, 3 and 13 were excluded. The results of the repeated procedure are shown in Table 4 and the related diagram of the relation

"$\ln\Delta C - \ln\Delta T$" is shown in Figure 2.

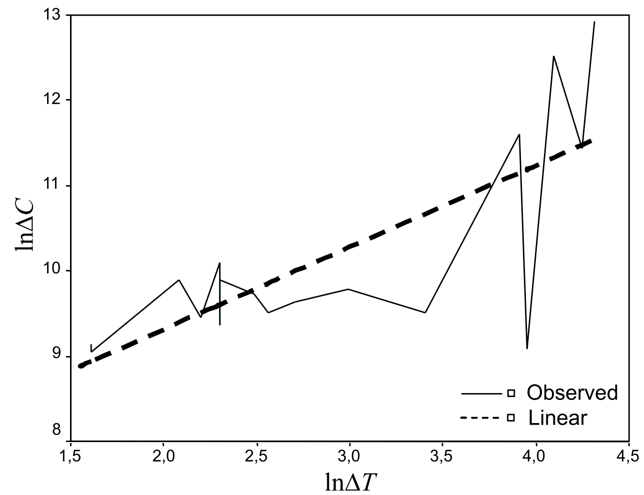

Figure 1 *Diagram of relation "lnΔC – lnΔT" for the whole sample*
Slika 2. *Dijagram odnosa "lnΔC – lnΔT" za cijeli uzorak*

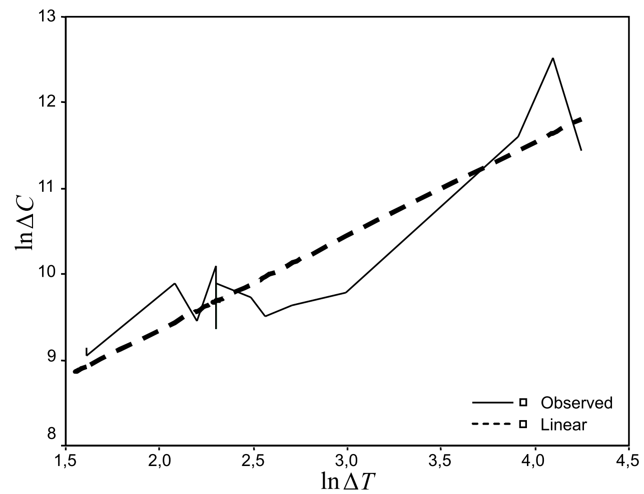

Figure 2 *Diagram of relation "lnΔC – ln ΔT" for the reduced sample*
Slika 2. *Dijagram odnosa "lnΔC – lnΔT" za reduciran uzorak*

Table 4-1 *Results of single regression for the reduced sample*
Tablica 4-1. *Rezultati jednostruke regresije za reducirani uzorak*

Model	*R*	R^2	AR^2	Standard evaluation error
1	0,0906(a)	0,821	0,808	0,4378
a Predictors: (free member), lnΔ*T*				

Table 4-2 *Results of single regression for the reduced sample - ANOVA(b)*
Tablica 4-2. *Rezultati jednostruke regresije za reducirani uzorak - ANOVA(b)*

	Model	Square sum	Grade freedom number	Variance	*F*	Sig.
1	Regional value	11,461	1	11,461	59,794	0,000(a)
	Residual	2,492	13	0,192		
	Total	13,953	14			
a Predictors (free member), lnΔ*T*; b Dependent variable, lnΔ*C*						

Table 4-3 *Results of single regression for the reduced sample - coefficients(a)*
Tablica 4-3. *Rezultati jednostruke regresije za cijeli uzorak - koeficijenti(a)*

Model		Non-standardized coefficients		Standardized coefficients	*t*	Sig.	95 % reliability interval for *B*	
		B	Standard error	Beta			Bottom limit	Upper limit
1	Free member	7,164	0,391		18,304	0,000	6,318	8,009
	lnΔ*T*	1,094	0,142	0,906	7,733	0,000	0,789	1,400

Table 5 offers the parallel review of linear regression parameters on the whole and the reduced sample.

Table 5 *Linear regression parameters*
Tablica 5. *Parametri linearne regresije*

Indicator	Whole sample	Reduced sample
R	0,740	0,906
R^2	0,547	0,821
AR^2	0,519	0,808

The strength of the relation between the dependent ΔC and the independent ΔT variable is expressed by the correlation coefficient R which has the interval from 0 to 1. If the correlation coefficient value is close to 0, the relation is considered to be weak. The determination coefficient R^2 which also adopts the value from the closed interval [0, 1] is the representative quality indicator of the regression model. The closer its value is to 1, the larger part of dependent variable variations are explained by the chosen model. When assessing the model representative quality, the corrected determination coefficient AR^2 is also applied. The determination coefficient is corrected in order to assess the authenticity of the chosen model more accurately. The value of this indicator is the same or lesser than the determination coefficient value.

2.5 Results of regression analysis
Rezultati regresijske analize

The obtained correlation and determination coefficients are in both cases within the acceptable limits. The zero hypothesis testing has likewise confirmed the assumption that the contracted construction price overrun is in function of the contracted time overrun for the structure in question. In other words, the test values F and t as well as the empiric values of the significance show that the described independent variable (the influential value) ΔT has a significant influence on the dependent variable ΔC.

Due to larger correlation and determination coefficients the reduced specimen results are adopted and the model parameter values K and B are determined.

$$\ln\Delta C = 7{,}164 + 1{,}094 \cdot \ln\Delta T, \quad (9)$$
$$K = 1292\,,\ \ B = 1{,}1.$$

As a consequence of risk factor influence on building construction structures – new construction, the regression equation for contracted price overrun due to contracted time overrun is obtained.

$$\Delta C = 1292 \cdot (\Delta T)^{1{,}1}. \quad (10)$$

One day of delay in constructing a building construction structure – new construction, will cause a contracted price increase of 1292 KM in average.

Table 6 offers the comparison of the estimated and effectuated contracted construction price overruns. The average relation of the estimated and effectuated contracted price overrun values is 1,0991, the minimum being 0,4218 and the maximum 1,9652.

***Table 6** Estimated and effectuated contracted price overrun values*
***Tabela 6.** Procijenjene i ostvarene vrijednosti prekoračenja ugovorene cijene*

Ord. number of the structure	$\Delta C_{(E)}$	$\Delta C = 1292 \cdot (\Delta T)^{1,1}$	$\Delta C / \Delta C_{(E)}$
2	24079,33	16265,32	0,6755
4	12672,00	14485,36	1,1431
5	11615,56	16265,32	1,4003
7	19805,38	12725,11	0,6425
14	110000,00	95527,74	0,8684
20	15204,86	25407,56	1,6710
21	93120,60	138315,34	1,4853
22	17741,00	34865,47	1,9652
23	9300,00	7588,04	0,8159
24	13381,31	21707,02	1,6222
25	276744,00	116742,47	0,4218
26	18600,00	16265,32	0,8745
27	16788,00	19877,51	1,1840
28	19835,00	16265,32	0,8200
29	8459,06	7588,04	0,8970
Where $\Delta C_{(E)}$ is the effectuated contracted price overrun value.		Average	1,0991
		Minimum	0,4218
		Maximum	1,9652
		Standard deviation	0,4431

3 Practical application of obtained results
Praktična primjena rezultata

For an office and residential building of 1 100 000 KM of value the contracted price overrun must be anticipated because there is a real assessment of risk factor influence on construction time of 246 days and its overrun due to those factors in the amount of 20,85 % (that is, for 51 days).

The formula (10) will be applied:

$$\Delta C = 1292 \cdot 51^{1,1}$$
$$\Delta C = 97\ 631{,}00 \text{ KM}$$

Consequently, for an office and residential building of 1 100 000 KM of value, both the planned construction time overrun of 246 days according to the "time-cost" model of 246 days for 20,85 % (that is 51 day) under the risk factor influence and the contracted price increase of 97 631 KM are to be anticipated.

4 Conclusion
Zaključak

It can be generally concluded that the hypothesis offered in the beginning has been confirmed because the obtained correlation and determination coefficients are within the acceptable limits. One day of delay in constructing the building construction structure – new structure, will cause the contracted price increase in average of 1292 KM. The model is easily applicable in everyday construction practice. The model is recommended to be applied in the region where the research was conducted – in Federation of Bosnia and Herzegovina or possibly in the regions with similar economic characteristics such as the post-transition countries of south-eastern Europe. According to the obtained information, no similar research characterized by the stated approach and goals has been conducted in these regions. The importance of the proposed methodology provides the initial base for planning the modern education for engineers, designers and contractors from the construction and planning field.

It must also be pointed out that this is only an introduction to the attempt of solving this issue and that it would be mostly recommendable to form a larger data base containing a larger number of structures with simultaneous time and price overruns which could be applied in some future research. Bearing that in mind a special attention is paid to the possibility and requirements needed for creating a historical and contemporary data bank with special reference to similar projects. What is proposed is a categorization of structures according to technical characteristics, contract awards, types of contracts, contracted price intervals, etc., that is, the most possible structure group homogenization and examination of possibilities to establish the model by using the nonlinear single regression and analysing the multiple linear regression. At any rate, the final goal all the research should be adapted to is the simplicity of model application in practice.

5 References
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