

Statistical modeling of residential complex construction project

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Abstract. The article presents a statistical simulation of the deviation of the project duration from the planned value. Regression analysis was carried out - a method of statistical data processing that allows measuring the relationship between one or more causes (factor characteristics) and the consequence (effective characteristic). The end result is a curve and a correlation coefficient, which with a certain probability will allow us to predict the amount of pecuniary injury in this project.

1 Introduction

In the practice of modeling systems, one often has to deal with objects that contain elements of stochasticity or exposed to stochastic effects of the environment, which, in turn, affect the duration of construction. Therefore, the main method of obtaining results using simulation models of such stochastic systems is the method of statistical modeling on a computer [1, 2].

2 MS Project statistical modeling

In the Microsoft Project software package, statistical modeling of the deviation of the project duration from the planned value was performed. The first step was a regression analysis - a method of statistical data processing that allows you to measure the relationship between one or more causes (factor features) and the consequence (effective feature). The work of the generator was carried out under the condition that the baseline cost is less than zero, the percentage of delay-5% of the base duration.

Unexpected deviations given the statistical variation in the duration of 1274.87 to 1321.04 days taking into account the period of return (Fig. 2). On the basis of the basic plan, the method of determining the probabilistic values of the duration, taking into account the acceleration or delays in the project, depending on unforeseen factors, 50 variants of the duration of work were obtained, the pecuniary injury for each of these options was determined [9-14].

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	Name	Statistic duration(t)	Cash flow(rubles)	Baseline cost(rubles)	Scheduled duration(d)	Generator	Scheduled NPV	Statistic NPV	Pecuniary injury(rubles)
0	Res. complex	1299.84	402 303 306.00	402 303 306.00	1269	0	459342448.71	455266118.3	4076330.41
1	Parking 1	300.82	-121 872 289.00	-121 872 289.00	289	299.33	-133606377.64	-134068505.57	462127.93
2	G corp	461.72	-217 983 276.00	-217 983 276.00	460	473.56	-249843253.05	-250811270.09	968017.05
3	Parking 2	231.58	-117 555 679.00	-117 555 679.00	230	240.07	-126544333.1	-126594317.6	49984.5
4	H corp	422.45	-226 796 616.00	-226 796 616.00	418	429.85	-257421034.09	-257981286.46	560252.37
5	Parking 3	210.76	-54 964 834.00	-54 964 834.00	204	205.96	-58236228.18	-58592727.65	356499.47
6	K corp	326.54	-163 897 200.00	-163 897 200.00	316	322.32	-179390929.99	-181070379.08	1679449.09
7	Earnings	0	1 305 373 200.00	1 305 373 200.00	365	0	1464384604.75	1464384604.75	0
8	Parking 1	365	9 744 000.00	9 744 000.00	365	365	10930945.72	10930945.72	0
9	G corp	365	494 423 600.00	494 423 600.00	365	365	554650814.09	554650814.09	0
10	Parking 2	365	9 312 000.00	9 312 000.00	365	365	10446322.51	10446322.51	0
11	H corp	365	479 584 600.00	479 584 600.00	365	365	538004231.22	538004231.22	0
12	Parking 3	365	4 320 000.00	4 320 000.00	365	365	4846232.09	4846232.09	0
13	K corp	365	307 989 000.00	307 989 000.00	365	365	345506059.13	345506059.13	0

Fig. 1. MS Project calculation of pecuniary injury.

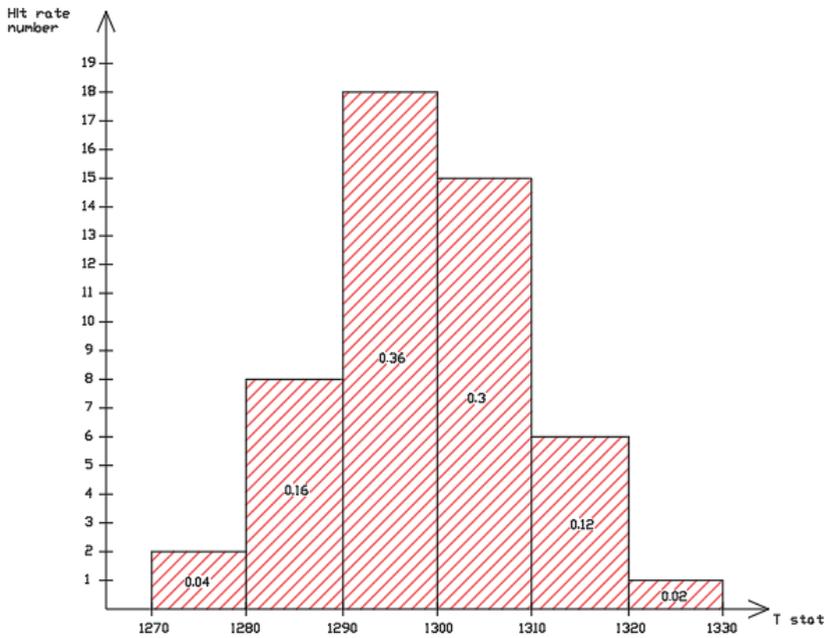


Fig. 2. Distribution of the static duration of monetary damage by intervals.

On the basis of the basic plan, the method of determining the probabilistic values of the duration, taking into account the acceleration or delays in the project, depending on unforeseen factors, 50 variants of the duration of work were obtained, the pecuniary injury for each of these options was determined. The monetary damages were divided into 6 intervals with a step of 1 000 000, the values of static duration-into 6 intervals with a step of 10 days (Fig. 3) [8].

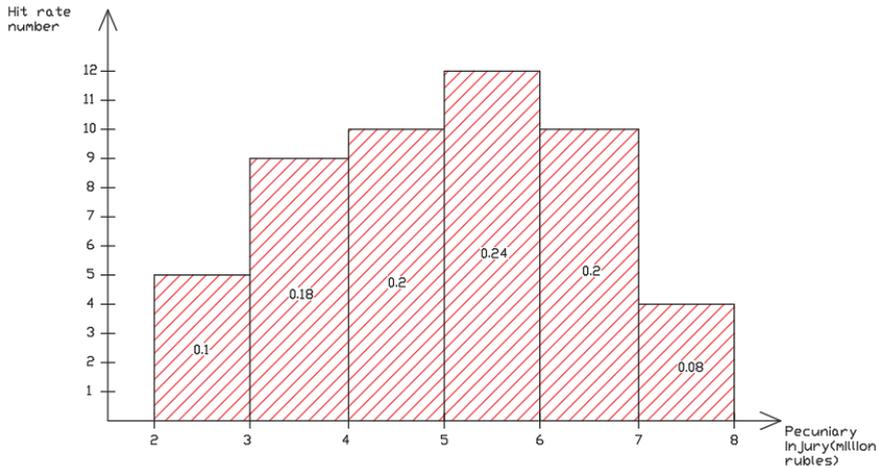


Fig. 3. Distribution of the static duration of pecuniary injury by intervals.

3 MS Office Excel statistical modeling

Performed statistical modeling consists in the construction and evaluation of the adequacy of the probabilistic model of the process of capital construction. For x_i adopted statistical duration of construction (days). The number of K_i measurements in which x_i values are observed and the relative frequencies of n_i are determined.

The following values are obtained:

Mathematical expectation $M(x)=1298.6$ days.

Dispersion of a random variable $D(x)=115.04$ days.

Standard deviation $\sigma=\sqrt{10.73}$, showing the dispersion of the values of a random variable (duration) relative to its mathematical expectation.

The correlation analysis is carried out and the regression equation is made. The purpose of correlation analysis is to identify estimates of the strength of the relationship between random variables – duration and loss, which characterizes the construction process. For X accept statistical duration (days), Y – loss (rubles).

$X_i ; X_{i+1}$	1270-1280	1280-1290	1290-1300	1300-1310	1310-1320	1320-1330	Sum
k_i	2	8	18	15	6	1	50
n_i	0.04	0.16	0.36	0.3	0.12	0.02	1
$x_i k_i$	2550	10280	23310	19575	7890	1325	64930
$x_i k_i / n_i$	51	205.6	466.2	391.5	157.8	26.5	1298.6
$Mx = 1298.6 d$		$Dx = 115.04$		$G = 10.73$			
$X_i ; X_{i+1}$	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	Sum
k_i	5	9	10	12	10	4	50
n_i	0.1	0.18	0.2	0.24	0.2	0.08	1
$x_i k_i$	12 500 000	31 500 000	45 000 000	66 000 000	65 000 000	30 000 000	250 000 000
$x_i k_i / n_i$	250 000	630 000	900 000	1 320 000	1 300 000	600 000	5 000 000
$Mx = 5 millions$		$Dx = 2.09E+12$		$G = 1.445 683$			

Fig. 4. MS Office Excel calculations of statistical values of durations and pecuniary injury.

The following values are defined:

- Sample averages:

$$\bar{x} = 1298.27; \bar{y} = 5043674.01$$

- Sampling dispersion averages:

$$S_x^2 = 104.26; S_y^2 = 2205917940724$$

- Standard deviation

$$S_x = 10.21; S_y = 1485233.3; S_{xy} = 13061688$$

As a result, the correlation coefficient $r_{xy}=0.86$ is obtained. This value shows that the relationship between the statistical length and loss is high (on a scale of Chedoke value falls within the interval of $0.7 < r_{xy} < 0,9$).

The regression equation:

$$y = 125285x - 157610149$$

The coefficient $a=243114.34$ shows the average change in the effective indicator (in rubles) with an increase or decrease in the value of the factor x (duration) per unit of its measurement. It turns out that with an increase of 1 unit y increases by an average of 125285.

The coefficient $b = - 157610149$ formally shows the predicted level y , but only if $x = 0$ is close to the sample values.

The relationship between y and x determines the sign of the regression coefficient b . If $b > 0$ is a direct link, $b < 0$ is an inversely proportional. In this project link is inversely proportional.

4 Results and Discussion

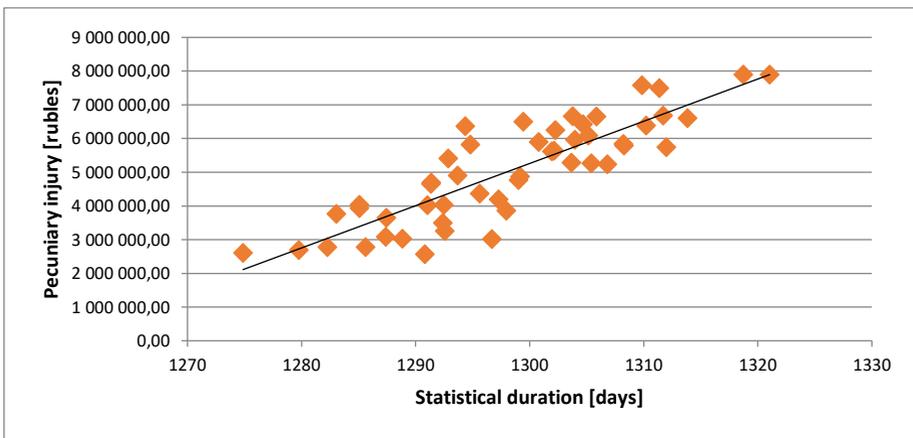


Fig. 5. Value distribution graph.

5 Conclusions

The conducted correlation analysis and the obtained correlation value allow us to conclude that the degree of tightness between days and pecuniary injury is high, which indicates the reliability of the project of capital construction of the residential complex.

Thus, with high probability it is possible to predict the amount of pecuniary injury from late completion. All data of duration and pecuniary injury have a Gaussian distribution (Fig. 2,3).

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