Access to construction time objectiveness

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ONE FROM IMPORTANT REQUIREMENTS OF SUCCESSFULLY MANAGED BUILDING PROJECT IS DETERMINING OF CONTRACT PARAMETERS (MAINLY TIME AND COSTS) ALREADY IN PROJECT PREPARATION PHASE. SUCH CONSIDERATION REQUIRES A SIGNIFICANTLY OBJECTIFIED ANALYSIS OF BOTH INFLUENTIAL PARAMETERS. Our research is focused especially to risks resulting from construction process acceleration. This phenomenon is in construction evident for several years. The construction processes parameters allow the time regulation of every operation. For all that the contractor must consider fairly, by what measures and at which "rate" he is able to perform the contract construction time. On the other hand the client must accept objective time possibilities of construction and reconciliation of time parameters between client and contractor must occur.

The paper presents an approach to reconciliation of construction time parameters between client and contractor and affords opportunity to model the trend of contract construction times in various projects segments. The spatial and organizational possibilities of construction process development in individual projects segments determines the measures for performance of construction time similar to contract construction time as more as possible.

Fifty five construction projects were analyzed. Considering the heterogeneousness of their spatial and technological structure, these projects were divided to following segments: multifunctional buildings, shopping centres, production plants and residential buildings. Trends of contract construction time and simulated measures impacts (construction time shortening) were derived for all the segments.

The paper presents a possible approach to objectification of building time parameters. The point of the research consists in estimation of expected time limits for intended construction that are necessary for client as well as for forward contractor.

Keywords

construction time performance, construction time shortening, project decision, regression analysis

INTRODUCTION

It is possible to employ many theoretical or methodical approaches to manage the construction projects successfully and effectively. The construction processes are the point of these projects management. The results are more or less difficult constructions, complexes or complete investment units. One from requirements of successfully managed building project is determining of contract parameters (mainly time and costs) already in project preparation phase. As much, construction time that is too long, as well as one that is too short, can have a negative impact on the project economic success. For this reason, construction time forecasts play an important role in early project phase (Stoy *et al.*, 2007). Such consideration requires a significantly objectified analysis of both influential parameters. Each of them is influenced by various factors, from the real to so-called speculative.

In the research being made at our institute, the time factor was analyzed in detail. The research was focused especially to risks resulting from construction process acceleration. This phenomenon is in construction evident for several years. Nowadays, almost in each construction project the contractor suffers from big constraint to construction time shortening from client side. Naturally, almost every client wants to have construction built at the soonest. Such situation has been before actual economic crisis and there exist arguments, why it will more continue. In time of economic crisis interest in investment is decreasing and so, when clients decide to invest, they may impose conditions. The contractor must take decision about by himself acceptable risk level.

In construction project the construction time is one from important contract parameters. It is usual in construction practice, that clients want to have construction built at the soonest; hence they ask the contractors to contract the short construction time. Their aim is to have quickly returned the capital contributed to the building. On the other hand, the contractors agree with the short construction time, in order to win the job.

It is true that construction processes parameters allow the time regulation of every operation. The works can be accelerated after more sources disposal. More sources disposal generally expects more costs, better work organization, higher work potential, increased works intensity including safety risks increasing, etc. For all that, the contractor must consider fairly, by what measures and at which “rate” is he able to perform the contract construction time. On the other hand the client must accept objective time possibilities of construction and reconciliation of time parameters between client and contractor must occur. The model for construction time objectiveness is one from possibilities for quickly estimation of construction time, objectified considering possible measures for its performance.

Bromilow (Bromilow, 1969), as the first one, was dealing with construction time problem and developed a regression model, known as Bromilow`s time-cost model, that can be used by clients and contractors for estimating and benchmarking the contract period of construction projects. One shortcoming of this model (Walker, 1994) is, that it fails to consider other factors than cost when establishing the contract duration. Walker`s research has indicated (Walker, 1995), that construction management team performance plays a pivotal role in determining construction time performance and has revealed an important relationship between sound client`s representative management effectiveness and good construction time performance. Afterward, few other statistical models were developed for predicting the duration of a construction project. All these models were based on the use of project-scope factors as the primary variables represented by construction cost, gross floor area, number of storeys and project complexity levels. Some models also incorporated management attributes, e.g. effectiveness of communications and speed of decision-making among contracting parties. Eventually (Chan, 1995) other measures of project-scope in deriving time prediction models, e.g. building volume, have been used in Hong Kong studies. The total building volume is one from significant variables identified from regression exercises, influencing the actual overall duration (Chan, 2002). Chan also found (Chan, 1999) the best predictor of average construction time of building projects in Hong Kong and identified (Chan, 2004) a set of critical factors influencing construction durations of public housing projects in Hong Kong. The relationships among the actual construction time/cost and other contract details were examined through ninety-three completed construction projects in Australia (Skitmore, 2003) and was developed the model for actual construction time forecast when client sector, contractor selection method, contractual arrangement, project type, contract period and contract sum are known or contract period and contract sum are estimated. An alternative model to that proposed by Bromilow was developed also in Australia (Love *et al.*, 2005). The analysis was performed between project time, project type, procurement method, tender type, gross floor area and number of stories. Equally, on the basis of two hundreds German properties (Stoy *et al.*, 2007) were identified the relevant construction speed drivers and their causal relationships were presented in a regression model. In our research, the construction time was investigated on the basis of total building volume of fifty-five construction projects built or being prepared in Slovakia in recent years.

Modelling of entry data for time analysis

Analysis of each construction process can be made by four principal construction structures.

Spatial structure presents spatial division of construction (into individual buildings), spatial division of building into technologically integrated parts (under work, frame, roofing, face, ...) or working areas (area, mounting section, ...) with emphasis on their progressive ranging into construction process, need of working area development as well as machinery arrangement. Technological structure presents division of building process into stage and partial construction processes. Decomposition of the building into technological stages and chronological aggregation of partial construction processes are the result. Each partial process is from point of technological structure characterised by works volume, by their work productivity, by number and composition of needed professions, by number and composition of machinery, technological break etc. Time structure indicates individual construction processes duration and their interconnections following technological, organizational and safety relativities. Specification of construction progress and total construction time in regard to stipulated terms performance is the result. Construction site structure defines essential conditions of site so as the planned processes could be provided by necessary material, machinery in needed places of site and in needed time, including provision of social and hygienic conditions for workers.

All four structures of construction process interact and changes in one structure prove in other three. For example after division of ten storied building into more areas is possible to put on more work teams of various professions. This means the construction process acceleration, but on the other hand, parallel spatial demands on site place, parallel demands on material storage for every team, parallel demands on location of machinery and workers needs assurance come.

As it was introduced in the beginning, price and time are determining contract parameters. Experiences suggest that for both, client and contractor, the price is overriding. Evenly some contractors say, that in case of money sufficiency, the time is not important and so they are prompt to agree or undertake whichever construction time.

It is true, that there are many possibilities for construction time shortening. Generally the construction time could be shortened by technological or organizational measures, hence by change of technological or time structure parameters. In such measures belong:

- exchange of higher productivity technology to lower,
- elimination of wet processes from building,
- technological breaks shortening,
- bigger number of sources putting on,
- work in prolonged shifts or more-shift service.

But most of these measures are restricted and so limited by space available for construction processes development abreast of individual structures as well as of the construction as complex.

For creation of the model we investigated a big number of existing and preparing construction projects. The contract construction time and the building volume of these projects were known parameters. Roughly rounded quantities for building volumes of preparing projects were deduced from design studies. Precisely defined quantities for building volumes were known from already built construction projects, so these data could be precisely measured. From such data is possible to derive so called "trend" dependency, which reflects the time requirements of investors. Fifty-five construction projects were analyzed. Considering their spatial and technological structure heterogeneousness the projects were divided into following segments:

- multifunctional buildings
- shopping centres
- production plants
- residential buildings.

Testing was made considering the standard construction time (SCT) in order to find out how "short" were the analysed times. As the standard construction time was the construction time under "standard" conditions:

- working time – eight hours / five days a week
- one-shift service
- composition of working teams according to technological receipt (minimal numbers of workers in team)
- technological breaks.

The construction time was explored on the basis of building volume (m^3). For modelling of SCT the software CONTEC has been applied. It is an automated system for construction preparation and realization (author of CONTEC - prof. Jarský). The software use to be applied for creation of offers and for building-technology projection in construction companies. The standard construction times at analyzed sample was modelled on platform of standard flowcharts of individual buildings segments, accounting working area for building works development. Comparison of SCT with contract construction time (CCT) of analyzed projects indicated that the contract construction time is in most cases several fold shorter than standard construction time (Figure 1). Interpretation of this fact comes from aforementioned standard conditions for estimation of SCT, that are in reality always adapted to needed construction speed (more working teams, longer working shift, seven days working week etc.). From Figure1 is evident, that the difference between CCT and SCT is bigger in case of large construction. In such constructions is bigger potential for construction time shortening (more possibilities for parallel and flow putting of production sources).

Then, regarding the particularities of spatial and technological structure of individual project segments the dependability between construction time and building volume was investigated. The dependability was explored by regression analysis – setting the statistical function Linregrese a Loglinregrese (Kalická and Krivá, 2005), as the points in diagram mostly suggest the form of such dependability. Determination of regression line or curve by regression analysis and their definition by regression function for account of building time estimation for entered building volume was the main task. In case of dependability existence, its amount was investigated by correlation analysis. It was defined according to value of determination index r^2 (Figure 2).

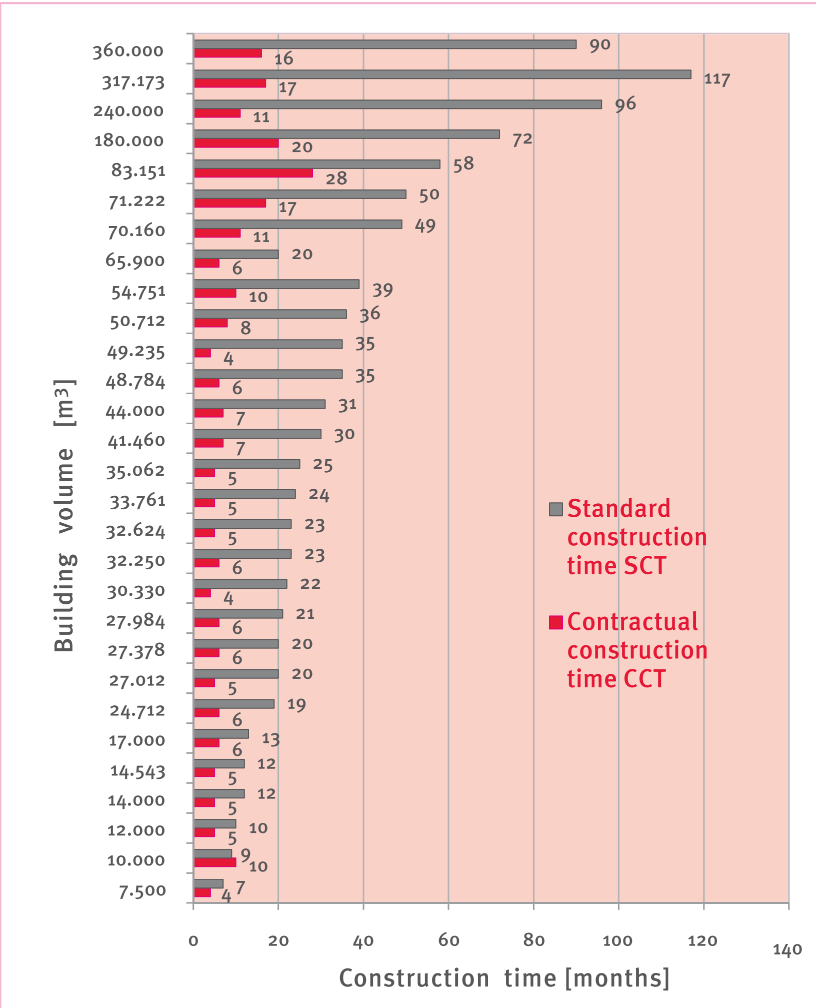

Figure 1. **Comparison of SCT and CCT in shopping centres segment**

Approaches to modelling of construction time shortening

Comparison of CCT and SCT was made for necessity of measures proposal for contract construction time performance. The measures proposal comes from possibilities of technological structure parameters modifying. The measures proposal is focused mainly on modification of worker amount, working time length, working week length, shift system, working teams paralleling and their combinations. As CCT is out of SCT (Figure 2), it is necessary to do iteration of SCT to CCT by some measures. In this analysis, following measures and their combinations were applied:

A – addition of two workers in each process
B – six days working week
C – seven days working week
D – double-shift service
E – two parallel teams in processes on critical path
F – combination of measures B + E
G – combination of measures A + B + E
H – combination of measures C + E
I – combination of measures A + C + E
J – combination of measures C + D
K – combination of measures A + C + D

By such measures taking and by simulation of technological structure applying CONTEC, standard construction time was shortened more or less. So the standard construction time was more similar to that of contract construction time. These measures are applied to models of individual projects segments in order to find in what shortening of the construction time the measures could be taken (Figure 3). According to results, even the contract construction time could be shortened by some measures.

Each work intensifying by measures entails some risks. In standard construction time the lowest exposure is evident. The exposure grows after some specific measure taking into model for

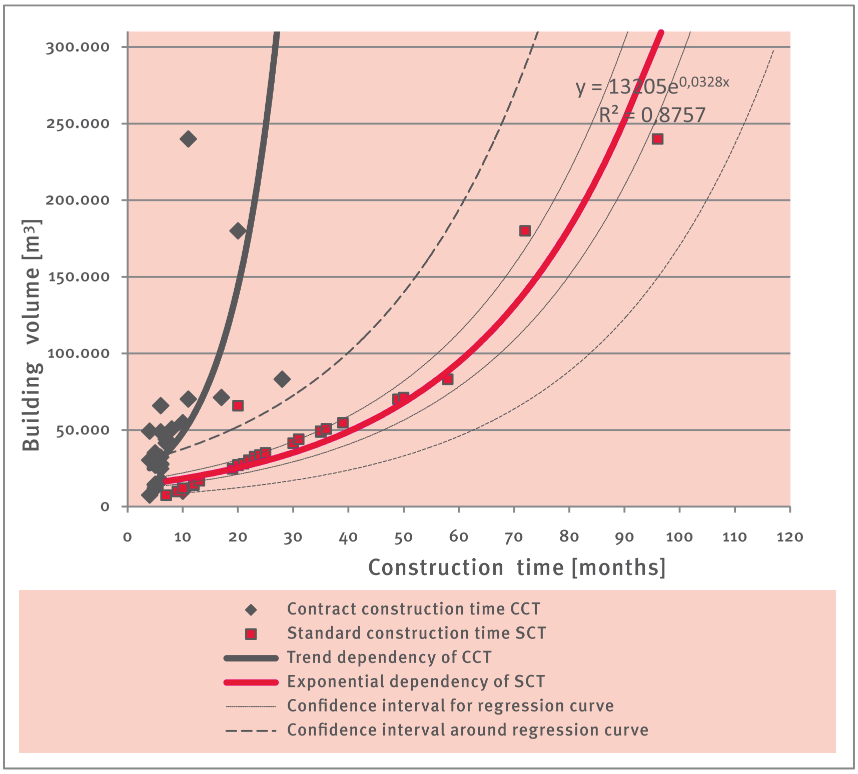

Figure 2. **Dependability of CCT and SCT in shopping centres segment**

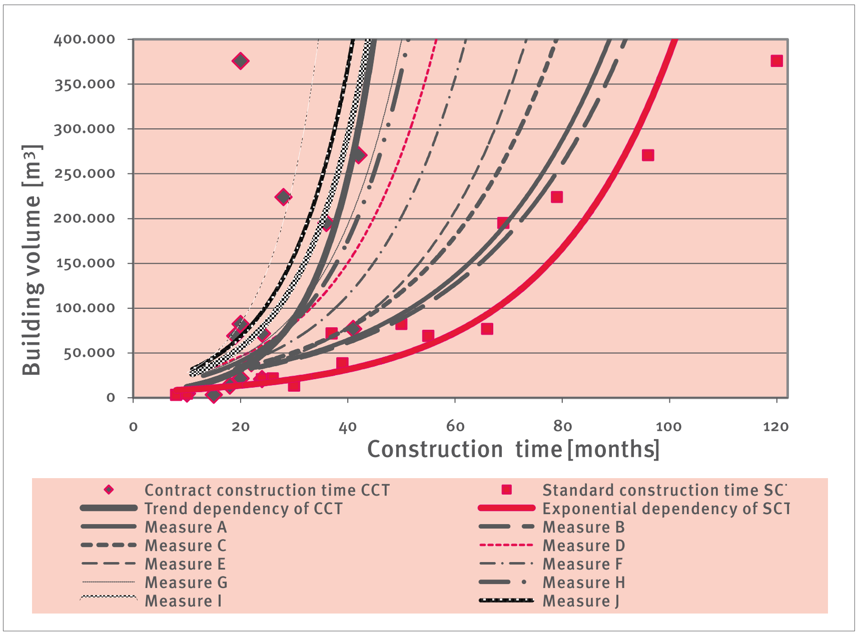

Figure 3. **Impacts of the measures for construction time shortening in multifunctional buildings segment**

standard construction time shortening. More measures bring bigger exposure. From the diagrams is evident that closing of dependability SCT and trend dependability CCT involves bigger exposure.

Studies of the measures impacts

By modelling of time structure of the projects sample and by aforementioned measures taking, more or less shortening of standard construction time has been achieved. The individual studies of the measures application consist of each taken measure evaluation, description of incurred situations induced by measures and generalization of the measures within specific project segment. In general, three situations occur:

- standard construction time was shorter than contract construction time,
- standard construction time was the same as contract construction time,
- standard construction time was more or less similar than contract construction time.

The impacts of measures applied at the project of Production building Nafta in Plavecký Štvrtok are presented on the Figure 3 and Figure 4. In this project, the standard construction time was 36 months and the contract construction time was 13 months. The construction time had to be shortened from 36 months to 13 months, what was achieved by the measure "K" application, so the standard construction time became the same as the contract construction time. The other measures haven't brought necessary shortening (Figure 5).

The analyses of the measures impacts were made in detail for all projects within each segment. The results were captured graphically (Figure 6) as well as in tables. Tabular evaluation of construction time shortening average after application of individual measures in individual project segments mentioned an interesting fact (Table 1). Resultant averages of construction time shortening, in per cents, are in individual analyzed project segments almost identical.

After synthesis of presented knowledge we could say, that in application of measures from A to K is not necessary to divide the projects into individual segments (as it is needed for estimation of standard construction time SCT), because the measures impacts are the same in all segments.

Figure 4. **Production building Nafta, Plavecký Štvrtok**

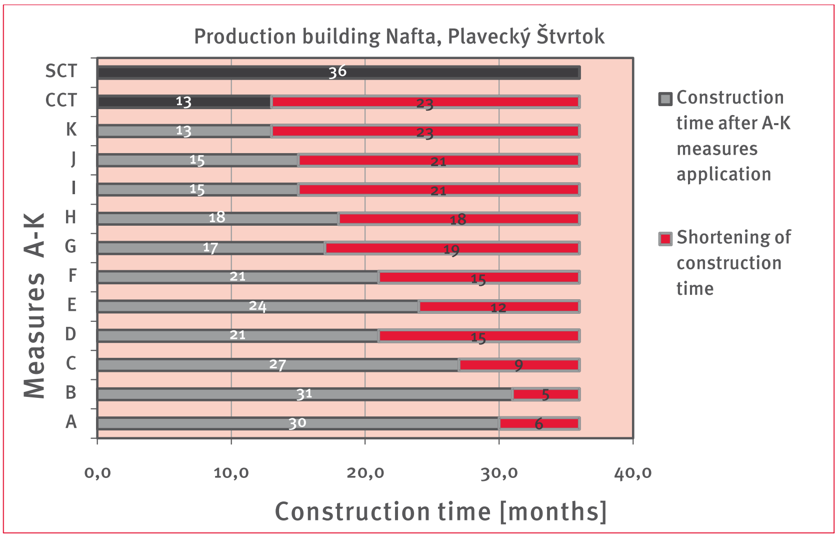

Figure 5. **Impacts of the measures applied at Production building Nafta, Plavecký Štvrtok**

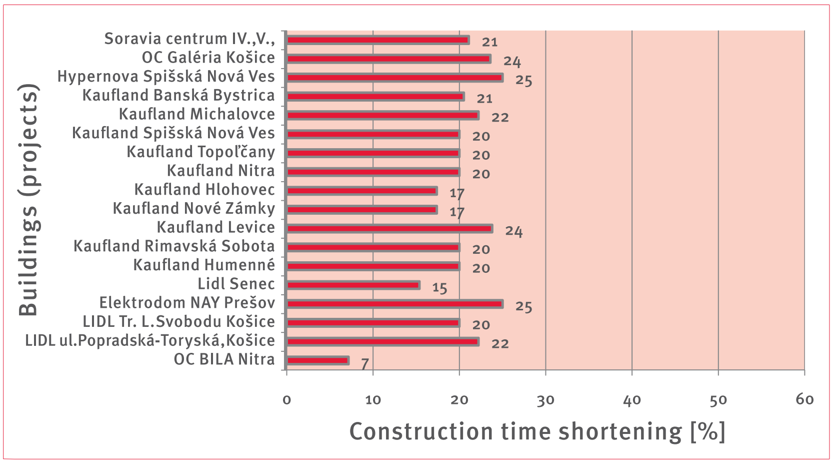

Figure 6. **Construction time shortening by the measure „A“**

CONCLUSION

The paper presents a possible approach to objectification of building time parameters. For taking the project actions and following creation of models for possible construction shortening is directly necessary to estimate the construction time of individual project segments. The point of the research consists in estimation of expected time limits for intended construction, necessary for client as well as for prospective contractor.

The phenomenon of "short construction time" is evident for a longer time, moreover nowadays in term of economic crisis implications existing. Clients call for contracts with short construction terms. The contractors must agree with short terms in order to be successful in competition. As client has many possibilities to make a choice, the winner is the contractor as much as possible disposed for the client requirements, disregarding the risks resulting from construction time shortening. Short contract terms should be concluded after particular analysis and by applications of measures relating to spatial and technological structure. The paper suggests that when principles of selected construction methods are not broken and when particular working speed is performed, short construction time could be accomplished.

Measure	Average shortening in %			
	Shopping centres	Multifunctional buildings	Production plants	Average of all segments
A	20	17	18	**18**
B	17	15	14	**15**
C	28	26	25	**26**
D	45	47	42	**45**
E	27	27	29	**28**
F	37	39	39	**38**
G	48	50	51	**50**
H	47	47	48	**47**
I	55	56	56	**56**
J	58	60	57	**58**
K	65	65	63	**64**

Table 2. **Impacts of construction time shortening measures**

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