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Problematics of financial savings in road buildings and design of one tool to control costs in projects

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Abstract

Decreasing of public budgets is a widely discussed topic even in traffic infrastructure. In such large projects, savings can be achieved by diminishing budgets or by higher efficiency of road building projects. There are many problems with preparing of projects, acquisition of land, corruption during competition, unhealthy competition, controlling of projects. In the Czech Republic, there exists a complex system to control road building, nevertheless every system has it issues. The article proposes a new approach to save financial costs on road building by assessing of bill of quantities from designer, which could be implemented into a complex system.

Keywords

Road buildings, budgeting, controlling, bill of quantities, Czech highway agency, construction budget

Introduction

During economic crisis in Czech republic in years 2009-2014, public budgets on building projects were decreased because of public demand. State organizations looked for ways to save money and gain best value. When building highways, the measure of value for money is characterized by building more kilometres at lower costs or by building the same number of kilometres in a better quality, which can diminish operating costs. In 2013 it was found out what the average costs are on road buildings in the Czech Republic (see Tab. 1).

Table 1 - Average costs on road building [1]

|  |  |
| --- | --- |
| **Description** | **Price without VAT** |
| Average cost to build 1 km of highway | 416 mil. CZK |
| Average cost to build 1 km of fast road (lower level of highway) | 378 mil. CZK |
| Difference in comparable construction costs between Germany and Czech republic (per 1 km of finished highway) | 27% |
| Increasing costs during first level of building permit | 68% |
| Increasing costs during second level of building permit | 37% |

Increasing costs during building permits is caused by time extension of permit, demands of interested parties for adding new building objects into project, another demands for changing objects in project, including demands of environmental organizations. The important information from table 1 is that e.g. in Germany, it is possible to build roads for lower costs (27 %). Second important information is that the difference in costs is concerns comparable construction works. Therefore, it is not caused by additional demands.

The lower cost of building roads can be caused by:

* Different unit price
* Different scope of work

Different unit price is influenced by delivery costs, raw material costs, labor prices, working productivity, overhead, margin of company. These variables are characteristic for each country and are influenced by market conditions (degree of competition, monopolization), stage of infrastructure development, technological development of country. The other cause is different scope of work. In project it is defined by bill of quantities from designer. For understanding the importance of bill of quantities, it is necessary to explain construction project management in Czech highway agency. Czech highway agency as a client has different agreements with designer/architect and contractor (construction company).



Picture 1 - Scheme of construction project [2]

Czech highway agency obtains project documentation from the designer. The documentation includes bill of quantities. Competition of tenders follows from the data in bill of quantities. Bill of quantities is estimated by contractors and the best one is chosen according to contemporary key e.g. lowest price, ecology, sustainability etc. The bill of quantities and related itemized budget is created by a pricing database and one of the software available on market. In the Czech Republic, ASPE with its price database is used for road construction. Czech highway agency does not check the bill of quantities neither in content nor degree. According to inner regulations of Highway agency, they monitor real scope of work and then confirm total amount of works. Nevertheless, if you look closely at budget spending, everything is usually spent. (Source: documents of project of Czech highway agency). The purpose of this research is to find out if there are differences between scope of work caused by way of calculation of creator of budget (bill of quantities). The author assumes that there will be differences within the range of about 3% of scope of work. Such assumption is based on author's practical experience.

Finding differences in a road project in the Czech Republic

Author gained documentation of realized road project from Czech highway agency including drawings, bill of quantities and price of winner of contest.

**Description of project**

A new lane was designed as an addition to an already existing road. It will double the width of the existing road. It is a fast road (lower level of highway).

* Length: 6400 m
* Width: 11,5 m
* Type: S 11,5

**Financial structure of budget**

* Total amount of costs on project: 575 mil. CZK
* Total amount of costs of construction works: 386 mil. CZK (67 %)
* Total amount of additional costs: 189 mil. CZK (33 %)

Structure of construction works

The biggest part of costs on body of road are communications (tab. 3) according to divisions of itemized budgets in software ASPE. These constructions are covered in the end; they do not stay as the top layer of finished project. Therefore, it is hard to check quantities after finishing. Bill of quantities created by designer and then used by client (Czech highway agency) does not specify calculation method of quantities. It is surprising, because it is in contradiction with law of public works in the Czech Republic. The law specifies that bill of quantities must include calculation method and also a description of the way calculation is made. [3] Excavation works are very difficult to estimate in designing phase. It is not possible to know real conditions of soil. However, it is not any easier when evaluating, because all constructions are covered and there are no exact data. For this type of project, the only opportunity to determine the actual scope of work, is during construction. Contemporary new technologies are for instance laser scanning. Foundations include drainage layer of geotextile, remedial layer of geotextile, drainage aggregate layer, remedial aggregate layer. It is not a significant part of financial costs – only 11,98 %. Other structures and works include additional works, e.g. protectors, crash barriers, direction columns, culverts, asphalt cutters, sealing expansion joints, troughs, rigols etc. There is no discrepancy in bill of quantities because it can be monitored even after works are finished. Author calculated quantities according to project drawings on part of communications of budget, because communications involve the biggest part of financial cost (57 % of costs of own body building). It was found out that there were differences of scope of work. (viz. Tab. 4 below). Items which were not marked yellow (item number 10, 13 and 14), were not specified in project. It is not possible to control these quantities. It is repair of old and new layer; it is hard to forecast scope of work. Author suggests that quantities are right. Nevertheless, it can be considered like potential savings. Not that the whole amount could be saved, but it can be for instance diminishing of these amount about average potential savings, which was calculated below. It was found that there is a financial difference between designer‘s budget 20,78 mil. CZK i.e. 5,37 % from cost of SO 101 and 3,61 % from total costs of project.

Table 3 - Budget structure of road body (source: authors)

|  |  |  |
| --- | --- | --- |
| Recap |  |  |
| Excavation works | 68 839 042 Kč | 17,82% |
| Foundations | 46 259 763 Kč | 11,98% |
| Communications | 221 380 019 Kč | 57,31% |
| Other structure and works | 49 800 786 Kč | 12,89% |
|  |  |  |
| Total SO 101 | 386 279 611 Kč |  |

Conclusions and recommendation for clients

Before exact calculations author hypothesized that deviation of bill of quantities will be 3 % from his own experience of budgeting of construction buildings. Calculations showed that on all specific project of road building it is 3,61 %. This result is exact proof of premise that money can be saved on construction projects not only by competition of unit prices of contractors but precise controlling of quantities of project. Therefore, it should be controlled, but problem is time when it should be controlled. Now all quantities are controlled during construction project and after it is built. As we described above not all types of construction can be checked up after being finished. From financial document (Recap of billing) it is clear there were no diminishing items on project. According to author it is usually practice of construction business. This knowledge should serve the client (state organization in case of road building) that he can control and save finance in the phase of choosing a contractor. It is clear that the process has to be joined with monitoring of usual unit prices of construction work. Supervision of quantities can be provided by private independent surveyor or by organization unit in Highway agency. This is not the only one precaution of saving money. There is another precaution which is not used by Czech highway agency, although calculations proved it has got potential to save money to state. Consequently, it should be added to complex control system of Czech highway agency.

Table 4 - Assessment of part Communications of budget SO 101 (source: authors)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Item number | Code of construction | Describing of item | Unit of measure | Quantity - designer | Quantity - author | Difference | Unit price | Total price before assessment of quantity | Total price after assessment of quantity | Financial difference |
|  |  | **Communications** |  |  |  |  |  |  |  |  |
| 1 | 56310 | Pavement layer of mechanically solidified aggregates MZK 0/32 th.. 200 mm | m3 | 15 473,6 | 13760 | - 1 713,6 | 2 116 Kč | 32 742 138 Kč | 29 116 160 Kč | -3 625 978 Kč |
| 2 | 56330 | Pavement layer of crushed gravel - gravel 0/63 th. Min. 180 mm | m3 | 14 196,2 | 13760 | - 436,2 | 1 188 Kč | 16 860 874 Kč | 16 342 752 Kč | -518 122 Kč |
| 3 | 56932 | Strengthening of crushed gravel roadsides th. Max. 100 mm | m2 | 6 400,0 | 3200 | - 3 200,0 | 130 Kč | 829 440 Kč | 414 720 Kč | -414 720 Kč |
| 4 | 572121 | Infiltration spraying asphalt max 1,0 Kg/m2 | m2 | 77 368,0 | 72000 | - 5 368,0 | 31 Kč | 2 359 724 Kč | 2 196 000 Kč | -163 724 Kč |
| 5 | 572212 | Connecting spraying of modified asphalt max 0,5 kg/m2 - 0,2 kg/m2 - under the bottom layer of cover + under wearing course | m2 | 283 230,0 | 131200 | - 152 030,0 | 20 Kč | 5 636 277 Kč | 2 610 880 Kč | -3 025 397 Kč |
| 6 | 572214 | Coupling the spray from a modified emulsion max. 0,5 kg/m2 - 0,35 kg/m2 | m2 | 77 368,0 | 65600 | - 11 768,0 | 23 Kč | 1 794 938 Kč | 1 521 920 Kč | -273 018 Kč |
| 7 | 572214 | Coupling the spray from a modified emulsion max. 0,5 kg/m2 - 0,2 kg/m2 | m2 | 75 868,0 | 65600 | - 10 268,0 | 20 Kč | 1 509 773 Kč | 1 305 440 Kč | -204 333 Kč |
| 8 | 574174 | Asphalt concrete class. I modified th. 80 mm - ABVH I - TP 109 th. 80 mm (ACL 22 S) | m2 | 69 868,0 | 65600 | - 4 268,0 | 540 Kč | 37 756 667 Kč | 35 450 240 Kč | -2 306 427 Kč |
| 9 | 574234 | Asphalt mastix modified class I tl. 40 mm, AKMS I - TP 109 th. 40 mm (SMA 11 S) | m2 | 68 428,0 | 65600 | - 2 828,0 | 301 Kč | 20 583 142 Kč | 19 732 480 Kč | -850 662 Kč |
| 10 | 574234 | Asphalt mastix modified class I tl. 40 mm, AKMS I - TP 109 th. 40 mm (SMA 11 S) - resurfacing of the existing roadway strip | m2 | 68 734,0 | 68 734,0 | - | 301 Kč | 20 675 187 Kč | 20 675 187 Kč | - Kč |
| 11 | 574621 | Coated aggregate class I thickness max 100MM - modified OKH I - TP 109 th. 70 mm (ACP 22 S) | m2 | 74 368,0 | 65600 | - 8 768,0 | 459 Kč | 34 097 728 Kč | 30 077 600 Kč | -4 020 128 Kč |
| 12 | 574621 | Coated aggregate class I thickness max 100MM - modified OKH I - TP 109 tl. 80 mm (ACP 22 S) | m2 | 75 868,0 | 65600 | - 10 268,0 | 524 Kč | 39 754 832 Kč | 34 374 400 Kč | -5 380 432 Kč |
| 13 | 577204 | Treatment joints asphalt material - transverse joints | m2 | 29,4 | 29,4 | - | 277 Kč | 8 152 Kč | 8 152 Kč | - Kč |
| 14 | 577407 | Layer recovery, repairs of asphalt concrete modified - repair of local faults on the existing roadway and on section of new roadway | m3 | 911,1 | 911,1 | - | 7 432 Kč | 6 771 147 Kč | 6 771 147 Kč | - Kč |
|  |  | **Communications - total price [CZK]** |  |  |  |  |  | 221 380 019 Kč | 200 597 078 Kč | -20 782 941 Kč |

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References

1. Ing. Eduard Hromada, Ph.D., Ing. Petr Matějka, doc. Ing. Dana Měšťanová, CSc., doc. Ing. Renáta Schneiderová Heralová, Ph.D., doc. Ing. Aleš Tomek, CSc., Fakulta stavební ČVUT v Praze, *Zvýšení efektivnosti přípravy a realizace dopravních staveb*, 2013.
2. *Předpis č. 230/2012 Sb. Vyhláška, kterou se stanoví podrobnosti vymezení předmětu veřejné zakázky na stavební práce a rozsah soupisu stavebních prací, dodávek a služeb s výkazem výměr § 7 – Výkaz výměr*.
3. Ministerstvo Dopravy ČR – *Inner prescription of Czech high agency, Výkon stavebního dozoru na stavbách pozemních komunikací*, MD-OSI, č.j. 999/09-910-IPK/1, Praha 2009.