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RISKS IN THE COSTING AND BUDGETING

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Abstract

Construction contracting belongs to those areas of business which are financially demanding and where changes in the operating phase abound. Construction budget needs to be a transparent and efficient means of communication between the contractor and the client. In order to minimize capital investment while achieving optimal operational cost alignment of costing software with Building Information Modeling is necessary. One of the most important drivers of a robust budget is the quality of entered data (the bill of quantities and unit prices). This will allow responding to all dynamics in prices, savings or budget overruns in a timely manner.

Keywords

Risks in construction, Building Information Modeling, the life cycle of buildings, costing software.

Introduction

The importance of creating a construction budget lies in accounting for all the possible costs that may arise during construction. Therefore it is essential for the budget to follow a clear structure. That structure is nowadays represented by the costing system. Following construction data and costing principles is of utmost importance, as is project documentation processing and maintaining the standards of craftsmanship, making a contract for work, and many other concerns. However, construction product assortment displays extreme variety. As a result, any of the categories of goods stated in a construction contract may change considerably over the period of investment phase, not only material-wise, but also in costs. Such situations are possible and likely because construction projects are being carried out in long production cycles.

BIM in price estimates and costing

BIM model brings a vast amount of partial benefits, from advance visualization methods, to simplified construction management or lowering the operational costs of finished construction. In construction project, there usually is high risk level in the first stages of the project. Such risk level is caused by the need of large financial expenditures which have to proceed gradually. If these expenditures are not managed carefully, they may cause failure in overall project management.

Correct input data is necessary in order to create a realistic price estimate. Input data may also be viewed as potential risks influencing expenditures in the investment and operating phases. The risks in the project life cycle may therefore be divided in risks caused by human, technical, and political factors. The influence of these risks on the project life cycle is not in effect during the entire project life cycle. These individual risk factors are more likely to affect various phases of the project, each one of them in their own particular time.

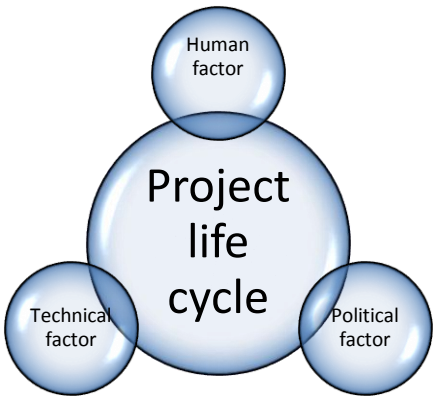

Figure 1: Pattern of risk factors influencing a construction project life cycle (source: author)

BIM use in costing

Should we talk about costing or construction costs, the term as such means a structured sum of expenses which arise on the basis of a specific human activity. Sooner or later, any member of the building proceedings is confronted with a financial estimate or costing. Although each member of the proceedings considers the costing from his viewpoint, the goal of all members is the same – to find out how much a construction, or any given activity included in the construction, will cost. The essential prerequisite for costing therefore is the output of BIM software applications, such as:

- Bentley Architecture

- Nemetschek Allplan Architecture
- Graphisoft ArchiCAD
- Autodesk Revit Architecture

While designing a construction project, collisions of operations have to be taken into account, as they would lead to inadequate costing. In other words these collisions would cause double pricing of the same kind of work.

In the Czech Republic, following software programmes are the ones most often used for the purposes of costing:

- BUILDpower
- KROS plus
- euroCALC

If we want to process data correctly, the items, measurements and bills of applications used to design projects need to match the items or aggregated items of costing applications. Furthermore it is important that costing applications state predominantly usual prices of goods, not only prices arising from continual indexing. Structure of item (or aggregated) prices requires a format that allows for frequent updates over short periods of time. This would enable the software to mirror current market prices. Consecutively the applications would simplify reacting to price changes, possible savings or impending budget overruns. Frequent updates of the costing applications and linking aforementioned applications to BIM would lead to major savings of both time and money not only in the planning and investment phases, but also in operating costs of the building.

Risks connected to BIM in price estimates and costing

Risks caused by the human factor

- Project documentation

- Quality of materials in relation to lower operating costs (repairs, replacements, etc.)

In the planning phase, decisions are made that influence the project's safety, durability, layout, and technical equipment. If the construction is to be in accord with building standards, project documentation should state material demands, technology specifications, and quality of craftsmanship in execution of the project. Building standards are a key issue in both designing and executing a construction project. Unfortunately, the client (developer) often does not take into account further aspects, such as operating costs, which are closely connected with the durability and quality of materials used in construction. BIM brings important assets to such situations because it links all phases of the project, from project documentation to facility management. This attribute of BIM thus brings into the picture also the owners, future owners, or facility managers of the building. For these individuals the output is important because the quality of building project and execution result in monthly operating costs (pre-payments, etc.).

- Bills of quantities

- Collision of building constructions within one area (the project stated constructions as overlaying each other). When doing bills of quantities, it is immensely important that one construction should not overlay the next. Which means that there should not be double insertion of a ceiling board in the same height or several walls in the same spot.

- Inaccurate bills of quantities

Building Information Modeling will assure accuracy of counting in the phase of adding up individual items. BIM will be operated by human factor but lower the high risks of mistake.

Risks caused by technical factors

- Project documentation

Building Information Modeling enables analysis of solar and light models while creating a construction project. These analyses simulate the incidence of sunlight on the projected building. This helps analyse the shadows of neighbouring buildings or find the optimal architectonic layout. It also allows the architect to simulate the daytime cycle and design lighting on the grounds of the building's location. These analyses may lead not only to better technical and technological parameters of the project, but also for ensuing analyses and simulations of the operating phase, and support solutions that lead to energy savings.

The problematics of maintenance and reconstructions is a major part of the sustainability debate. In this respect, BIM tools can be used for detailed analysis of particular project specifications. This should result in optimal usage of given space without unnecessary wasting of water or energy sources. Furthermore, the application should make it simpler to plan construction so that maintenence and potential reconstructions are as unproblematic as can be. It calls for use of easily repairable items that do not require much maintenance, and for a project of a building that will take into account its sustainability in the operating phase.

- Bills of quantities

- Calculation of unidentifiable items (air, etc.)

Building Information Modeling enables smarter work, more efficient production, better output. BIM is a tool to be controlled and adapted, but there is a large number of individual problems that have to be solved. Many of them are already accounted for, some need further correction. An example of these is the automated creation of bills of quantities. It is easy enough to make a list of the model's individual items. However, the list has to be checked for missing construction parts, corrections have to be made, errors removed. One of the current errors is counting areas and volumes of air as if they were construction units.

- Realization budget

- Updating prices in costing software

Human sources are not absolutely reliable, and neither are technical sources or data. The range of construction products and materials is vast. Frequent updates of current prices and uploads of new items into BIM are therefore very important, as they can influence the price of project execution.

Risks caused by political factors

Political factor will impact any price estimates even without BIM. The individual risks (such as inflation rates, changes in construction law, state commissions law, price law, etc.) cannot therefore be blamed on the introduction of BIM.

Conclusion

The aforementioned data (risks) lead to the conclusion that Building Information Modeling does not replace human sources. Rather than that, it helps optimize the phases of pre-investment planning, designing a project, its execution, and operation. But all of these can only be accomplished by the human factor. Close connection of the human and technical factor are very important, and can lead to good results.

BIM implementation risks

Building Information Modeling implementation brings both economical and personal impacts. Firstly, software has to be bought by companies, which provide for activities connected with both

building, and operation of buildings. It might be necessary for some of these companies to buy new computers, capable of operating these demanding software programmes, which would raise the companies' operating costs. Thelength of the period of higher operating costs and lower productivity during implementation will depend on the capacities, knowledge, and understanding of the staff who will need to learn to operate the software and use it in the future. For the successful use of BIM, it is necessary that subcontractors also embrace the options of the programme with optimism, because subcontractors make up for a large part of the activities of investment phase.

The beneficial motivation for a company to implement BIM may be that cooperation with the academic environment and feedback on their actions would make them the leading company of the market. Feedback carried on in the form of data collection and their ensuing evaluation will strengthen the company and increase the productivity level of their employees.

Higher operating costs and lower productivity over the implementation period in the leading company or market challenger will be rewarded by organizing educational courses not only for the company, but also for other companies, nation-wide and further. Nevertheless, the leader of the market may not forget that competition is tough in construction and innovations. Therefore the company will still need to support customer loyalty and ensure added value for the customer in order to keep up their position, not to drop to the second place and become merely a market challenger.

BIM implementation will also influence investors, as the cost of purchase will be projected into investment costs of the project/building. The investor needs to be aware, though, that these investment costs will be appreciated in the long-term perspective because they lead to lowering of operating costs.

Last but not least, BIM implementation will influence the owner of the object. The lowering of operating costs will project itself in the figure of advance payments.

The list of risks follows in the ensuing table, for the sake of clarity.

Project participant	Risks
Contractor	Unwillingness to communicate with other participants
	Recovery of investment into BIM implementation
	Educating own employees
	Technical knowledge of the problematics
	Lax attitude of subcontractors towards BIM
Investor	Low appreciation of the benefits of BIM (investor does not take into account the sum of investment in the first phase, and operational costs in the following phase, and only focuses on the high investment cost)
Owner/ Facility manager	Technical knowledge of the problematics
	Knowledge of software using BIM

Table 1: Scheme of risks concerning project participants in the implementation phase of BIM (source: author)

Benefits of using BIM

Nowadays, most architects use BIM without necessarily being aware of it. BIM is based on 3D geometrical models, such as is the output of almost any construction design these days. By using BIM, the designers could solve the problem of collisions, which usually arises in construction execution. They could also define the properties of materials used, define the producer, price, and many other factors. That would simplify ensuing documentation processing. Estimator would not need to make a bills of quantities, as it would be easy enough to check the current one in BIM, correct errors, or fill in missing information, because errors are still made in BIM.

The main benefit concerning the investor would be the option to continually check project status. Data of the project are formatted and structured as a point of reference, with regard to the option of creating control analyses. Input data are very precise, therefore it is not necessary to recreate an analytical model every time. Additional benefit for the investor is reduced fixed costs by elimination of extensive amounts spent on operating and maintaining the asset.

Public Administration as an investor operates a large number of buildings. These usually comprise the city council, offices of various administrative departments, nursing homes, establishments for the handicapped, senior homes, nursery schools, primary and secondary schools. Centralized information is of essence when such a large number of facilities is to be managed properly.

By using BIM in Public Administration, anyone can demand information on a given building in the inventory, and also find out whether such information had been processed already. These actions would eliminate a number of very similar activities of the public administration (such as energetic audit, energetic license, ecological audit, internal audit, etc.) within different departments. This would further result in better management of financial means.

As can be seen from the aforementioned example, there are good reasons for BIM implementation, and ensuing usage in costing and financial management, in the government sector as well as in the private sector. The state as a client/investor with a large number of public projects is truly the leading investor in the market. Therefore it would be worth consideration whether it should not be up to the state to require all projects to be created in BIM. This would also simplify keeping up with EU's increasing standards.

Facility management's activities include actual facility management, utilization of these facilities, energy management, maintenance, janitorial services, etc. It is immensely important for facility management to process strategic and tactical plans for ensuring these supportive activities of FM in their entire range. Usage of BIM in the operating phase would make up for the shortcomings which facility managers have to face as soon as in the planning phase of a construction project. It would result in:

- Lower energy consumption
- Savings in facility management
- Efficient use of spatial properties of the object
- Easier planning of furniture and equipment changes

The list of benefits follows in the ensuing table, for the sake of clarity.

Project participant	Benefits
Contractor	Linking practical completion stage to architectonic design
	Linking practical completion stage to operating projects and simulations

	Simulations of energy consumption
Investor	Being in control of all project phases
	Processing changes and object demands (extrawork)
	Low operating costs
	Repairs and maintenance of construction items in short time segments
	Linking the frequency of repairs and maintenance to further investments
Owner/ Facility manager	Low operating costs
	Low frequency of repairs and maintenance resulting from the investment phase
	Information on maintenance of construction items
	Simplified bills of construction units, areas, and bills of quantities

Table 2: Scheme of benefits for project participants using BIM (source: author)

Conclusion

It has been shown that linking costing programmes to BIM would streamline the creation of construction budgets, financial estimates, estimated dates of completion. It would summarize all information on suppliers of construction items, and make supervision easier. Current information and feedback fits the needs of both private and public sector. It is not yet possible to establish the economical benefits of BIM implementation with its higher financial demands for project designing, but lower costs of extrawork, which is the usual reason of budget overruns. The reference literature indicates the total cost of asset life cycle and covers the implementation of BIM but there is no reference to linking the cost in budgeting tools with eventual linking to BIM.

BIM is a useful tool not only for the planning, and investment phases, but also in the operational phase. It is an invaluable and beneficial tool for the future owners and managers of a given building.

References

[1] Martin Černý a kolektiv autorů. *BIM příručka*. Praha: Odborná rada pro BIM, 2013. ISBN 978-80-260-5279-5

[2] Nessim Hanna; H. Robert Dodge. Pricing, *Zásady a postupy tvorby cen*. Vydání. 1. Praha: Management Press, 1997.

[3] Pour Pavel, Ptáček Roman. *BIM projektování v ArchiCADu. Riba Publishing*, Vydání. 2. Praha: Grada Publishing, 2012. ISBN 78-80-247-4165-9

[4] Eric Wing. *Autodesk Revit architecture 2011 : no experience required*. Riba Publishing, Wiley Publishing, 2010. ISBN 978-0-470-61011-4.

[5] Matějka, P., Hromada, E., Anisimova, N., Dobiáš, J., Kovář, P., & Kozáková, I. (2012). Základy implementace BIM na českém stavebním trhu (1. ed.). Praha: Fineco.

[6] Kotler , P. *Marketing Management.* Praha:Victoria Publishing, 1991. 789s. ISBN 80-85605-08-2 .

[7] Hrazdil. Modelování a řízení výstavbového procesu pomocí programů CONTEC a BUILD-POWER. Praha: ČVUT Praha, Fakulta stavební, 2000.

[8] UNIKA. Sazebník pro tvorbu nabídkových cen projektových prací a inženýrských činností

[9] Lévy, François. *BIM in small-scale sustainable design*. Hoboken: Wiley, ©2012.

[10] Stave Race. *Bimdemystified. Riba Publishing*, 2nd edition.2013. ISBN 978-1-85946-5202-2.
[11] Reddy, K. Pramod. BIM for building owners and developers: making a business case for using BIM on projects. John Wiley&Sons,Inc. Hoboken, New Jersea.2012. ISBN 978-0-90598-2.
[12] Perez, FGL., Vanegas, SIC., Lopez, DM., Paaez, ECC. (2011). Methodological proposal of low cost for technical coordination in architectonic projects, a through to modeling 3D of building processes: study of case in housing popular. *2011 4TH International conference of education, Researchand innovation (ICERI)*, 6236-6245.
[13] Zheng, HK., Cao, JW. (2013). Discussing the Influence of BIM for the Construction Project Cost. *Ework and eBusiness in architecture, engineering and construction, pts 1-4*, 357-360, 2533-2536.
[14] Arlati, E., Roberti, L., Tarantino, S. (2009). BIM Towards design documentation: Experimental application work-flow to match national and proprietary standards. *Architecture, Building materials and engineering management, 495-505*.
[15] Volk, R., Stengel, J., Schultmann, F. (2014). Building Information Modeling (BIM) for existing buildings - literature review and future needs, *Automation in Construction*, 38, 109-127.
[16] Láska, PED., Simpson, I., Hill, Snading, C. (2013). From justification to evaluation: Building information modeling for asset owners. *Automation in construction,* 35, 208-216.
[17] Porwal, A., Hewage, KN. (2013). Building Information Modeling (BIM) partnering framework for public construction projects. *Automation in construction,* 31, 204-214.