COMPARATIVE ANALYSIS OF CREATING TRADITIONAL QUANTITY TAKEOFF METHOD AND USING A BIM TOOL

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Abstract

Quantity take-off is the foundation for the estimation of project costs. Usually they are made manually which can lead to a number of inaccuracies and mistakes. However, there are BIM programs that contain the tools needed for making a quantity take-off. The focus of this work is the trustworthiness of quantity take-offs made through the BIM method. Quantity takeoffs was created using traditional methods and using BIM tools (Revit). Results were compared and savings quantified.

Keywords

BIM; comparison; manual takeoff; quantity takeoff; revit

Introduction

This work focuses on the issue of creating quantity take-offs through BIM method. Quantity take-off is not without its purpose as it is an important part of the construction process. In early stages it is used for preliminary estimation of costs. It is used to decide whether or not a project is going to be realised. In the tender quantity take-off is applied in a more accurate cost estimation and as a basis for the choice of the contractor. During the construction it is used for economic direction of the project. Last but not least, it is possible to apply it in the operation phase of construction as a basis for determining the cost of possible reconstruction. [1, 2, 3]

Nowadays quantity take-offs are made traditionally with the help of 2D documentation or CAD tools. This usual approach consist of manual measurements of various elements, for example in ground plans, cross sections, and similar documents. Given its reliance on human factor it is very prone to inaccuracies as is 2D documentation. It is very difficult to draw complicated situation, like an interpenetration of multiple structures, and the probability of making a mistakes is proportionally higher. [2]

Alternatively, there are BIM tools that allow getting quantity take-off directly from a model. Such quantity take-off is based on geometrical properties of the model. It provides information on the surface area, volume, and other dimensions. BIM as a tool for quantity take-off should be used for facilitation and refinement of cost estimation in all phases of the construction. [2]

The following questions arise:

- Is the use of BIM method more expedient compared to the traditional one?
- Are the results of quantity take-off created via BIM tool correct?
- If not what causes the mistakes?
- How much time is saved when compared to the traditional method?

The research attempts to find answers to these questions.

Research content

The aim of the research is to find the solutions to the questions above. The problem is observed on a specific project provided by the company AED project, a.s. It is a single apartment building modeled in the program Revit 2014. The quantity take-off for this building was assembled both manually and with the help of BIM software. Both are compared to each other to find any deviations and their causes. It is all reliant on the chosen BIM tool for creating quantity take-offs, on the way the model was developed, and last but not least, on the principles used to make the quantity take-offs.

For the needs of this research the BIM instrument of choice is Revit 2014, which is the most used modelling tool, along with Archicad, in Czech Republic. Quantity take-off was made with regard to procedures defined in baseline construction price catalogues by ÚRS Praha which are used in public contracts for their full description of construction work. In Czech Republic, there are no other unified and obligatory norms for the creation of quantity take-offs. It is common practice to use the above mentioned catalogues.

The causes of deviation

Causes of deviation can be divided as follows:

- Deviations caused by a mistake of the accountant
- Deviations caused by a mistake of the designer

- Deviations caused by insufficient software capabilities

The following deviations were discovered in the apartment building project.

Causes of deviations caused by a mistake of the accountant:

- Incorrectly deducted volumes of openings (instead of deducting the volumes the surface areas of opening were deducted)
- The volume of a pillar was added to the lower edge of the panel without deducting the reinforced concrete girder
- The opening for the water drain was not deducted from the surface area of the attic because of insufficient amount of incisions in the 2D documentation

Causes of deviations caused by a mistake of the designer:

- Incorrectly made joints of vertical constructions
- Drawing of one type of a construction by multiple families
- Incorrect redrawing of foundations constructions received from the structural engineer

Causes of deviations caused by insufficient software capabilities:

- Lack of a tool for surface adjustments
- Lack of a tool for shuttering
- Wrong method of calculation of surface areas of vertical construction – the lengths are calculated without regard for actual shape
- Incapability of the software to comply with basic principles of calculation of baseline prices of constructions as presented in ÚRS Praha catalogues
- Insufficient tools for modelling groundwork, it is impossible to model groundwork with regard to current principles of budgeting

Possible solutions of the deviations:

- Disregard minor deviations up to a certain percentage
- Work out the problematic elements manually
- Modify the principles of creation of quantity take-offs
- Add more tools to Revit – for example the tool for surface adjustments
- Set principles of model creation so it is optimal for creation of quantity take-offs with consideration to the difficulty and benefit in quantity take-off issue

Conclusion

In the conclusion we can answer the questions asked in the beginning. The answers can help us determine which method of making quantity take-offs is more suitable for the current situation.

Are the results of the take-off created via BIM tool correct? If not what causes the mistake? Deviations between take-offs were found mostly in the take-off made via BIM method. However, for the purposes of this project the deviations are negligible. It is possible to make the claim that the results are correct.

How much time is saved compared to the traditional method? The amount of time saved using the BIM method for quantity take-off is very large, compared with traditional method it is about 80% faster. Detailed schedule can be found in Table 1.

Table 1: Time saved using BIM tool for quantity take-off (source: own)

Category	Contents	time [minutes]	
		Manual	Revit
Table of rooms	Floor and ceiling composition	40	20
Foundations	Pads, belts, slabs	125	20
Construction phase	Walls, pillars, girders	420	10
Vertical constructions	Masonry, isolation	450	30
Wall surface	Plasters, paints	330	20
Ceiling composition	Ceiling composition	20	15
Floor composition	Floor composition	40	15
Wall composition	Wall composition	100	20
Facade	Facade	240	20
Roof composition	Roof composition	20	5
Balcony composition	Balcony composition	50	15
Groundwork	Excavations, embankments, removal	120	-
Staircases	Staircases	60	-
Other construction and work	Cleaning, shining, covering	70	20
Tables for take-offs		-	130
Total		**2085**	**340**

Is the use of BIM method more expedient compared to the traditional one? The answer to this question is based on the answer to the previous questions. Given the large amounts of time saved and minimal deviations in the take-off the use of BIM method is advantageous for this project.

This case study shows that the result of the comparison of the two methods relies in a large part on the quality of the drawn model and on the chosen BIM tool for creation of the quantity take-off. Each BIM tool functions differently. The principles of deviations caused by BIM software are not universal. If a project of lesser quality were provided the situation might have been completely different, i.e. a quality project is a basic requirement for effective use of software and software quality cannot replace model quality.

For modelling a project with regard to quantity take-off we the following advice may be given: Model the project the way it is going to be built.

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