

ICIS Project: COST ESTIMATING AND BIM

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Executive summary

This ICIS report was created by members whose interest is in cost estimating and BIM and who develop cost estimating software. This report seeks to investigate cost-estimating systems in general, and how these systems are or can be BIM compatible.

A cost estimate is the approximation of the costs of the resources needed to complete the project activities. The accuracy will increase during the iterative loops of the planning phase. In the report other definitions are explained e.g. cost modelling, cost accounting.

The main purpose of cost estimation is to give the real estate owner all the necessary information to make cost effective decisions and choices based on output-input principle. Therefore, cost estimates should be divided into parts, which the person using the information is able to understand, and which creates specific service/quality for the real estate owner/user.

The report describes some cost estimating methods, tools and techniques and provide information about cost estimation systems in the Czech Republic, Norway, Finland and Switzerland.

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Project team

At the ICIS 2015 conference in June it was decided to initiate a new project. Since several ICIS members have a special interest in cost estimating and BIM and also develop cost estimating software, a project team was established for the purpose of writing a report on Cost estimating and BIM.

The project team is Geir Johansen (team leader), Norconsult Information Systems (NIS), (gj@nois.no), Barbora Pospisilova, URS Praha (pospisilova@urspraha.cz) and Kari Siren, Electrical Technology Ltd, Finland (kari.siren@sahkoteknikka.fi) The project team had a startup meeting at this conference to learn about cost estimating systems in the three countries.

Both NIS and URS Praha develop cost-estimating software, or collect and maintain cost data for estimating purpose.

Preamble

This report seeks to investigate cost-estimating systems in general, and how these systems are or can be BIM compatible.

Cost estimating

Definition

A cost estimate is the approximation of the costs of the resources needed to complete the project activities. The accuracy will increase during the iterative loops of the planning phase.

Estimating level

Table below indicates how classes correspond to common names, purposes and project definition level.

Estimate class	Name	Purpose	Project definition level
Class 5	Order of magnitude	Screening or feasibility	0% to 2%
Class 4	Intermediate	Concept study or feasibility	1% to 15%
Class 3	Preliminary	Budget, authorization, or control	10% to 40%
Class 2	Substantive	Control or bid/tender	30% to 70%
Class 1	Definitive	Check estimate or bid/tender	50% to 100%

Table 1

Switzerland has other definitions and other levels of cost estimates, which are widely used in the swiss market. The estimate classes refer to the SIA-phases for the construction process.

Other names for Class 5 estimates are conceptual estimate, pre-design estimate, preliminary estimate, evaluation estimate.

Cost modelling

Some use this term also. By definition, cost model is at set of rules, algorithms, equations used to estimate cost of a product or project.

Cost accounting

While cost estimating is an approximation, cost accounting is cost incurred and assigned to products, services or other objects to evaluate efficiency of cost usage.

- Actual cost accounting will take place when the final design is completed and the information regarding actual quantities are available.
- Cost accounting should be performed at the end of the planning phase but also during the bidding phase and execution phase.
- Cost estimating or cost accounting software could analyze data from the BIM database and calculate cost based on cost information gathered from other external databases. Cost information is not accurate in the way that for example product specifications are.
- The main purpose of cost estimation is to give the real estate owner all the necessary information to make cost effective decisions and choices based on output-input principle. Therefore, cost estimates should be divided into parts, which the person using the information is able to understand, and which creates specific service/quality for the real estate owner/user.

Different type of cost

When we talk about cost in the AEC industry we usually mean construction cost of a project, and that is also what most cost estimating systems is based on. In later years building owners have put more focus on other types of cost such as:

- Life-cycle costs, LCC, (whole-life costs)
- Environmental cost (carbon footprint, energy usage, sustainability)

LCC are the costs of operations, maintenance, replacement, supply cost, cleaning etc. These costs are possible to estimate based on the project cost of building elements, and their lifespan.

Environmental cost is more difficult because the “price” of carbon emission and energy largely depend on the source. Energy from hydropower is preferred to coal, oil or gas.

Both LCC and environmental cost should be considered and estimated in building projects.

Elemental method of cost estimating

A common method for cost estimating is the elemental method. It is an alternative approach for calculating the total estimated cost of building works (i.e. the building works estimate). The elemental method considers the major elements of a building and provides an order of cost estimate based on an elemental breakdown of the building project.

The elemental method can be used both in the conceptual and design phase, as well as by the contractor calculating the tender. The elemental method is also suitable for cost estimating with BIM.

Cost estimating in early project phase

Up to recent years cost estimating was a time consuming and manual process in each project. Usually it was done only once, and when most of the design was complete. Due to this the cost effect of different design alternatives was often neglected. By introduction reliable cost estimating models in the very early concept phase of a project, cost becomes a vital part of the design process.

Cost estimating for tender and bidding

After tender documents are submitted the contractor will make his cost calculations/estimate based on Bill of Quantities (BoQ) and give his bid on the contract. The contractors cost estimating process can utilize the BIM in the same way as in earlier stages of the projects. The BIM can be used for quantity take-off, project planning, time schedules, logistics, deliveries, constructability etc.

One has to consider that the BIM-model is not the whole truth of a project concerning costs.

- (1) All materials are not modelled, such as mortar, sealing foam, fittings,
- (2) All work that has no relation to components modelled in BIM, such as excavation, installation of cranes, construction site urbanization, ...
- (3) All work that drives cost instead of the component, such as drilling versus bored piles

Cost items on a detailed level with resources such as materials, labor cost/time, manufacturer and more is connected to each BIM object.

Cost estimating tools and techniques

There are several tools and techniques used for developing cost estimates. These are not discussed in this report. For further information see *Reference 2* Methods of cost estimating: <http://www.project-management-skills.com/project-cost-estimating.html>

BIM: Building Information Modelling

Previously BIM was often understood as the 3D graphical model produced in the CAD-software. This is not the correct understanding. BIM is also short for Building Information Models (BIMs). These are usually files (often but not always in proprietary formats and containing proprietary data).

A lot of activities, such as making "product data templates" (PDT) aim to provide this kind of information in future in a structured way. CRB will provide standardized PDTs and therefore minimize the information that will be provided in unstructured file format.

The definition of BIM is much wider than that, see below.

Definition

BIM is a digital form of construction and asset operations. It brings together technology process improvements and digital information to radically improve client and project outcomes and asset operations. BIM is a strategic enabler for improving decision making for both buildings and public infrastructure assets across the whole lifecycle. It applies to new build projects and crucially, BIM supports the renovation, refurbishment and maintenance of the built environment – the largest share of the sector. [EU BIM Taskgroup Handbook, 2018]

Open BIM

OpenBIM is a universal approach to the collaborative design, realization and operation of buildings based on open standards and workflows. OpenBIM is an initiative of buildingSMART and several leading software vendors using the open buildingSMART Data Model.

Description of cost estimating systems

This report covers cost estimating systems developed in the ICIS member's countries participating in this report.

Czech Republic:

URS Praha is the biggest provider of cost data in the Czech Republic building and construction industry and has a long tradition (more than 50 years) of collecting, maintaining and developing cost data. Main scope of company is services in area of construction specifications, pricing, budgeting, calculation of construction works, distribution of cost software KROS 4 etc. Other products include analysis and prognoses of construction industry development on both European and regional level for public and private purposes.

Cost/pricing system of URS Praha is compact system of information, methodological recommendations and guidelines for cost estimation and budgeting. It is the most used and popular system in the Czech Republic. It is updated twice a year, provided as a published documents and electronic database. It covers resources for cost estimation in all stages of construction process and lifespan of a buildings. It is used by cost estimators, developers, designers, contractors etc.

Norway:

Norconsult Information Systems (NIS) have developed two different cost estimating systems:

- **Calcus:** For early stage cost estimates, life-cycle cost and carbon footprint
- **ByggOffice:** Detailed cost estimates based on tender documents and Bill & Quantities. Resource cost calculations (materials, labor, machines etc.).

Both systems are BIM compatible and can make use of the IFC-format exported from most CAD systems. The two systems serve different purposes and are "linked" through NIS own specification system "Beskrivelse". Beskrivelse can import cost items from Calcus, add further specification items and requirement before the project with bill & quantities is submitted to the contractors for tender/bid.

Finland:

The Finish ICIS member company do not develop their own cost estimating software or cost database. However, there are many similarities between the Finish and the Norwegian systems. One of the major cost estimating solutions is the "Taku system" developed by Haahtela. It is based on the "Target price method".

Kari Siren and others have written papers about "Target costing" these will be made available on the ICIS website.

The target costing principles are:

- define functional criteria
- determine target cost
- design to the targets

For further information see www.haahtela.fi

Switzerland:

CRB in Switzerland provides very matured cost calculation classification schemes used by various software vendors to estimate and calculate costs in a comparable and legally secure way. There are two different concepts to do cost estimation and calculation:

- (1) Component-oriented and BIM compatible with the eBKP (eBKP-Gate) classification for building construction and civil engineering
- (2) Execution-oriented with the BKP classification

Below is a model of how Cost modeling in BIM could work. (Ref. Kari Siren)

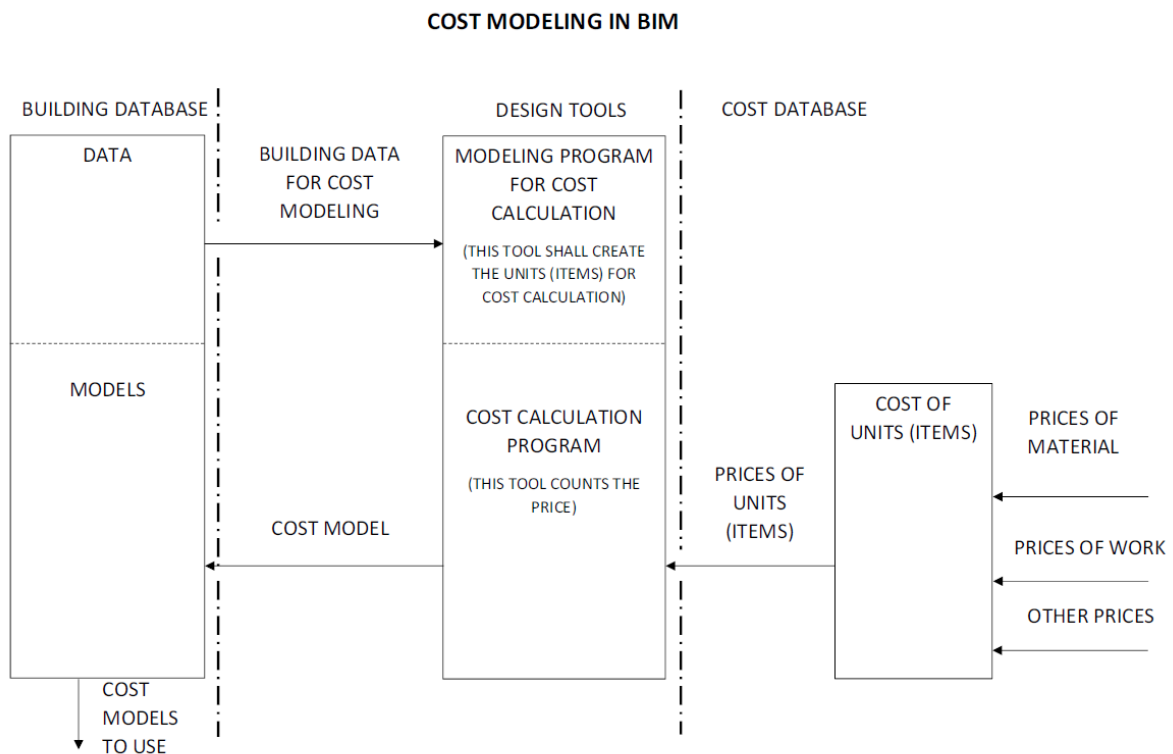


Figure 1

CRB have a more integrated way:

The eBKP (eBKP-Gate) classification will be integrated into the data structure of buildingSMART (openBIM)

>> IFC (first) and BuildingSMART Data Dictionary (in a second step)

With this integration one will be able to select in a BIM model all cost relevant components and export them with quantities via IFC for a cost calculation program.

Be aware that the issues mentioned under "Cost estimating for tender and bidding" are not yet solved. CRB will invest more into research how to integrate these aspects in a proper BIM cost estimation model.

Cost estimating with BIM

With the introduction of BIM, more information about the building became available earlier. Main quantities could be extracted from the BIM before final design was developed.

But only a certain part of the cost of a project can be linked to the building objects within the CAD model. Therefore, there is always a need for adding cost items or cost components/elements independent of building objects from CAD (BIM's).

Since the BIM normally is object based (such as a wall that consists of several items) the cost items/components should also be object based. Some cost databases have cost data on a very detailed level. Hence, it is difficult to link cost data to BIM objects.

There are normally many changes during the design process. These design changes are reflected in the BIM, and the cost estimate based on the BIM will also be updated when re-importing the model.

Challenges in Cost estimating with BIM

There are several challenges in cost estimating with BIM. One is reliable information such as quantities, object properties, classification methods, object naming etc. The need for BIM standards both on national and international level is very important to improve data flow between different systems.

As long as we do not have clear and precise modelling rules for BIM models, quantities will not be reliable. Depending on the way designers builds their model, the cost estimate will get different quantities.

CRB is working on modelling guidelines to increase the reliability of quantities.

In 2015 Standards Norway issued a new standard for BIM-Objects (NS 8360), *See reference 4*
This standard is also available in English. In addition, a guideline to NS 8360 standard has just been published (June 2017).

The process of BIM Based cost estimating

Below is an example how a cost estimate based on BIM can be made. The BIM model in Revit or other CAD-solutions is connected to the cost estimating software (Calculus). Cost components/items are added from the cost database and connected to the BIM objects.

The 3D model with cost data (building cost, Life-cycle cost and carbon-footprint) can be viewed in the cost estimating software.

CRB is testing an option by mapping the IFC-export of an author-tool to the structure of eBKP. With corresponding rules in a model checker software, the dimensions will be mapped from a 3D model into the eBKP cost classification.

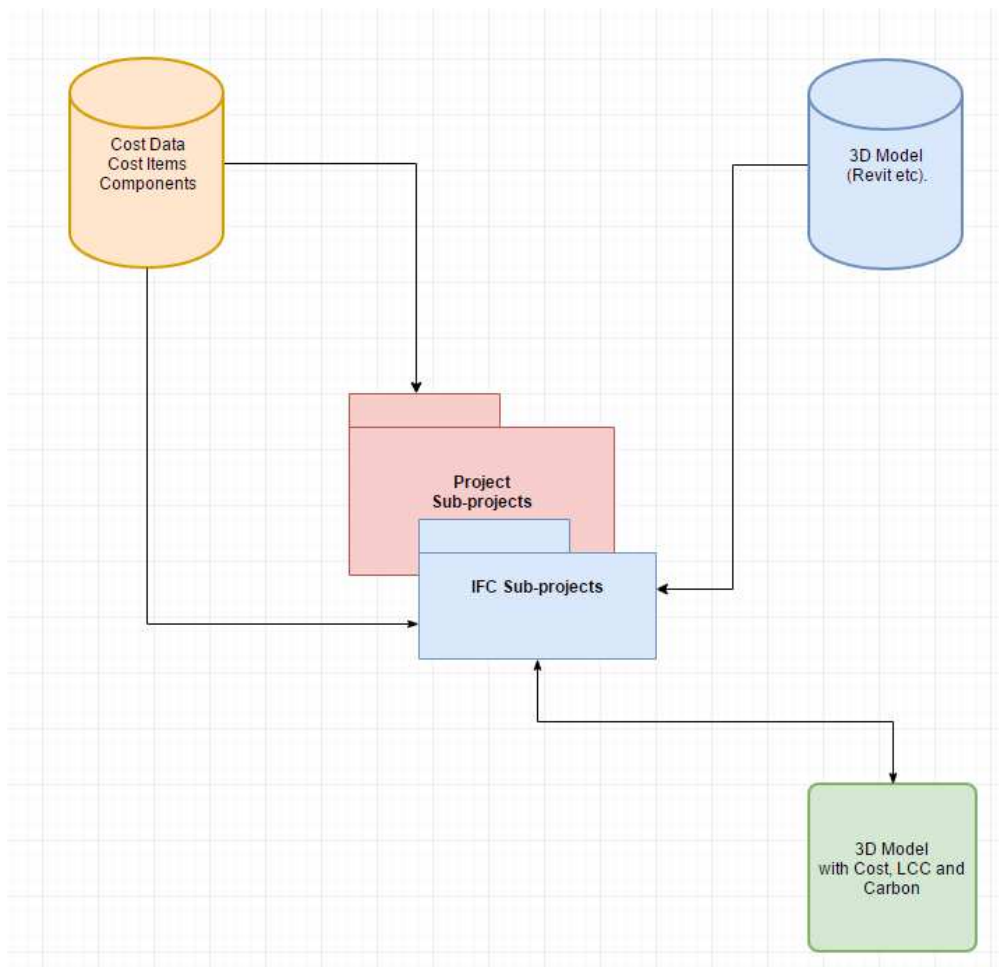


Figure 2

Levels of BIM (maturity of BIM)

The process of creating digital information about a building or facility is very broad. The “maturity levels” range for 0 to 4. Level 2 BIM is set as a minimum level for public projects.

For more information about levels of BIM see *Reference 3* Levels of BIM (Maturity) https://www.designingbuildings.co.uk/wiki/BIM_maturity_levels.

Survey of cost estimating practices

In 2000 Akintoye and Fitzgerald did a survey of cost estimating practices in the UK. These findings will most likely apply to other countries as well.

The ICIS report 31 have focused on methods and software solutions for cost estimating and BIM. These tools and solutions can add to making better decisions and better projects, but as the statement below indicates, the skills and practical knowledge of the estimators plays a major role.

The study shows that the major causes of inaccuracy in cost estimating continue to be the lack of practical knowledge of the construction process by those responsible for the estimating function, insufficient time to prepare cost estimates, poor tender documentation and the wide variability of subcontractors' prices.

Main factors relevant to cost estimating practice are complexity of the project, scale and scope of construction, market conditions, method of construction, site constraints, client's financial position, buildability and location of the project.

The broad usage of CRB standards for submissions, tenders and cost estimations in Switzerland allows for estimation accuracy of +/-10%. This is by the way independent of using BIM or not.

Recommendations/Summary

The project team have throughout the work on this report come up with some recommendations on how to succeed with cost estimating and BIM.

1. The BIM must be made with the purpose of reusing information downstream, not only for viewing. Information in BIM-objects must be structured, concise, classified and named in a machine-readable way.
2. To connect cost data to BIM-objects it is an advantage to have cost data on elements (walls, slabs etc.) rather than only on each layer of the element.
3. Cost estimates can be made from BIM other than 3D models from CAD-systems. Ref. the Finnish method as described in figure 1.

References:

1. Akintola Akintoye & Eamon Fitzgerald “A survey of current cost estimating practices in the UK” <http://www.ingentaconnect.com/content/routledg/rcme/2000/00000018/00000002/art00005?crawler=true&mimetype=application/pdf#expand/collapse>
2. Methods of cost estimating: <http://www.project-management-skills.com/project-cost-estimating.html>
3. Levels of BIM (Maturity) https://www.designingbuildings.co.uk/wiki/BIM_maturity_levels
4. SN/TS 8360:2015
<http://www.standard.no/en/webshop/productcatalog/productpresentation/?ProductID=922800>