**Discussions**

**1.)** Model based cost estimation has some crucial advantages. The first and the most important easiness is to have detailed cost estimation. It can easily calculate the used materials for a structural or an architectural element. It brings an important feature with it especially for complex project. There are several points that cannot be detected while estimating cost by hand but being a software, BIM based estimation take each detail into consideration. Another advantage is to accelerate the cost estimation part of a project. Model based cost estimation can calculate each quantification fastly. The only requirement for the estimation is defining unit prices.

However, there is a limitation of that type calculation. For instance, the special shaped elements which are designed for some architectural reasons may not be calculated exactly. There may be some mistakes while calculating surface area or volume.

**2.)** All quantities and specifications that are required for cost estimating calculation by Allplan tool. And data will be used in program is up to user.

Using unit price list is essential for making calculations of total cost of project. Each price of components will be used in the project should be determined one by one and this will take much more time. Alternatively, if program already have several unit price lists, this process will be quicker.

**3.)** Thanks to Navisworks,cost estimation can be actualized quicker and more systematical. In sentence meanwhile all advantages for model-based cost estimation are also valid. Detailed information can be obtained by Quantification tool. Whether one customize data in accordance with

requirement, it works easily. Hence excluding the redundant data in excel file will be less confusing.

**4.)** The quantity take-off calculation in Autodesk Navisworks Quantification is more accurate rather than hand calculation but it might contain error/mistake as much as each software does. So that, exporting all the information in the building model (.RVT) will happen with a minor mistake. After activating the selection tree option in Autodesk Navisworks, user can see all the details of structure like curtain wall, structural beam, roof, floor etc. Too many errors can be showed up in cost estimating phase whether not all the information is exported completely when the building model is converted to as a .NWC file. Also in Autodesk Navisworks program, some properties like dimensions of beams cannot be viewed clearly and this is a huge handicap for program. In addition this, some data might be lost when the file format is converted from .RVT to .NWC.

**5.)** There are several considerations that are done in Autodesk Navisworks Quantification. Firstly the units should be adjusted to have appropriate cost estimation. For example, unit of the concrete is m3 while volume of walls is m2. Another consideration in Quantification method is placing each item to the desired group. For example, foundation related jobs should be located in the group which major topic is Foundation. This work will reduce the errors due to double counted or counted out items.

However, it cannot be guaranteed the estimated cost will be the same in construction. To exemplify, this method does not cover all the items that will be done in the construction site. In Autodesk Navisworks Quantification there is nothing but material cost. To exemplify, pre-construction stage costs or labour costs are not covered. Moreover, there will also be minor differences of the material usage. Steel, as an example, is fabricated as being 12 m but it is not possible to use it at construction site with the most optimize option. There will definitely be loss of materials. Examples like these will cause discrepancy between real cost and estimated one in the software. **6.)** To estimate the unit prices of members of the structures,our team benefitted from related web-pages unit price list prepared by Republic Of Turkey Ministry Of Environment And Urbanization in 2017. Even though many resources are had got, material specification didn’t match with our list. In these times, we used educated guess. Also, unit price list can be integrated to Navisworks datatools.

**7.)** Automated quantity take-off has more advantages over manual one most of the time. Especially, the speed of the process considerably different between these two method. Since all structural elements are defined in computer program, it can easily find dimensions for each element’s dimensional properties and calculate the required amount of material. It will obviously be quicker than hand calculation. Automated quantity-take off, also is helpful for relatively large projects. It is very possible to miss out an element in the project for a person, but this is not a situation for a computer program.

Although having these properties, it cannot be said that automated quantity take-off has always the advantageous method. Connection details, for example, or various architectural elements cannot be defined in a software. So, without those elements it is not possible to do an accurate cost estimation. Another preferable property is being easily changeable when the project is revised for a specific element. Since all members are listed by hand changing a little part of project will not be hard. Instead of revising the project in the software, the needed change can be done easily on excel or hand-made list.

**8.)** There are still some uncertainities about modal based cost estimation. To have more reliable results, it should be checked after preliminary design since in that stage there is only geometric dimensions of elements. Errors could be easily eliminated if the software is used after preliminary design. Also, there are always unexpected costs in construction stage and software based calculation could never estimates these costs. In other words, if accurate results are desired the project in software should be simple.