

Figure 3 : 3D model of Holland Hall, University of Exeter using Aerial photogrammetry (3dwarehouse.sketchup.com, 2004)



Figure 4 : 3D model by Facade Image, (Shi Pu and George Vosselman, 2009)

3D models can be present in more detail by using Level of Details (LoDs) which is different scale of details and represent in CityGML . It can represent semantic, geometric, topology, and also appearance for virtual 3D city model base on field requirement. Then, CityGML information are stored and exchanged by GML schema and stored as a XML file. The attributes for surface models and some layers need to be created to recognize building features. As example for LoD3, building opening like windows, doors and stairs should be created in different layers and the information saved in semantic information XML files. After all the LoD represent in CityGML, extending CityGML are the so-called Application Domain Extensions (ADE) which is the introduction of new properties to existing CityGML classes like management of cultural heritage, the definition of new feature classes for ancient house, maintenance of heritage houses and others. Extended CityGML instance documents can be validated against CityGML and each ADE scheme (T. H. Kolbe. 2009).

2. METHODOLOGY

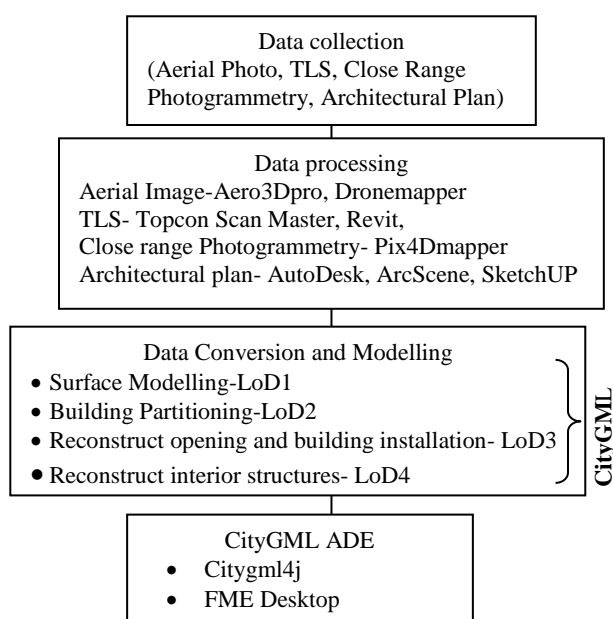


Figure 5 : Process from Data Collection until CityGML ADE

Based on figure 5, there are many methods available for data collection. 3D data such as Aerial Photo, TLS, Close Range Photogrammetry and Architectural Plan. I. Nazrita et.al, (2009) said among all these technique, digital 3D laser scanning method has proved to be produced. Researchers may make data processing base on data obtained. This process usually take a time to get the proper and quality modeling. Lately, CityGML always used to solve the problem in term of management and technical. CityGML also use in maintaining and preserve heritage site.

3. LEVEL OF DETAILS (LODS)

Researchers are trying to develop efficient and effective method to create 3D model but each methods has advantages and limitation (Surendra Pal Singh et.al, 2013). All the data must be process according to their respective methods, for example data collected using TLS will be processed using Smart Scan or Cyclone 7.3 that produce point cloud data and then converted into 3D software such as AutoCAD, Revit, Sketchup, and another 3D software. Then, the 3D model will be exchange.

The 3D models was converted into GML files for represent in any of an open source software such as LandXplorer. The layer were created as the attribute to give semantic information follow the CityGML file structure. Furthermore, LoD0 refer to building footprint, roof outline and 2.5D digital terrain model which is lower detail of model and useful for mapping and landscape planning. The highest LoD4 visualize the interior of building and more detail structure displayed. As example for refurbish heritage house, the high resolution textured 3D model need to use to check wood decay due to temites. Or introduces interior heritage house for tourism purpose to tourists in which use the LoD4.

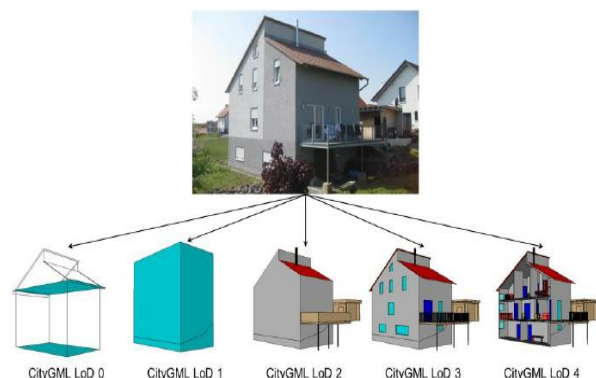


Figure 6 : Representation of a building using LoD0 - LoD4 (Löwner. M.-O, et.al, 2013)

Figure 7-9 shows the example of XML code for representing LoD1 (saved below the MultiSurface section without any building parts), LoD2 (WallSurface and RoofSurface) and LoD3 and LoD4 (Openings were created below the WallSurface section).

```

<core:cityObjectMember>
- <bldg:Building gml:id="#_lod1_BD.1">
- <bldg:lod1MultiSurface>
- <gml:MultiSurface>
- <gml:surfaceMember>
- <gml:Polygon gml:id="#_lod1_BD.1_PG.1">
- <gml:exterior>
- <gml:LinearRing gml:id="#_lod1_BD.1_PG.1_LR.1">
<gml:posList srsDimension="3"> -9.00198795098341
9.00198795098341 7.99444531653823 5.9683
5.32070415421027 5.968307 -24.9602477734
9.00198795098341 7.99444531653823 0.0812
0.081253 </gml:posList>
</gml:LinearRing>
</gml:exterior>
</gml:Polygon>
</gml:surfaceMember>
    
```

Figure 7 : Source code LoD1 (R. Akmaliaa et.al, 2014).

```

- <bldg:WallSurface gml:id="#_lod2_BD.1_WallSurface_49">
+ <bldg:lod2MultiSurface>
</bldg:WallSurface>
</bldg:boundedBy>
- <bldg:RoofSurface gml:id="#_lod2_BD.1_RoofSurface_1">
+ <bldg:lod2MultiSurface>
</bldg:RoofSurface>
</bldg:boundedBy>
+ <bldg:boundedBy>
+ <bldg:boundedBy>
+ <bldg:boundedBy>
+ <bldg:boundedBy>
</bldg:Building>
</core:cityObjectMember>
- <app:appearanceMember>
- <app:Appearance>
- <app:surfaceDataMember>
- <app:ParameterizedTexture>
    
```

Figure 8 : Source code LoD2 (R. Akmaliaa et.al, 2014).

```

<app:appearanceMember>
- <app:Appearance>
- <app:surfaceDataMember>
- <app:ParameterizedTexture>
<app:imageURI>/textures/Metal_Aluminum_Anodized.jp
<app:wrapMode>wrap</app:wrapMode>
+ <app:target uri="#_lod3_BD.10_PG.1">
+ <app:target uri="#_lod3_BD.11_PG.1">
</app:ParameterizedTexture>
</app:surfaceDataMember>
- <app:surfaceDataMember>
- <app:ParameterizedTexture>
<app:imageURI>/textures/Translucent_Glass_Corrugate
<app:wrapMode>wrap</app:wrapMode>
    
```

Figure 9 : Source code LoD3 (R. Akmaliaa et.al, 2014).

4. EXTENDING CITYGML

CityGML ADEs has to be defined within an extra XML schema definition file with its own namespace. The advantage of this approach is that the extension is formally specified. The ADE concept support two different methods which are the existing CityGML classes can be extended through additional attributes and in ADE schema, new classes can be derived from existing CityGML using generalization concept (Romain Nouvel et.al, 2015). Thus, the ADE can use for any management such as Noise ADE, Energy ADE, Solar ADE and also Heritage ADE. According to J.Finat et al (2010), they create CityGML framework by adding three task to support the software application (GIRAPIM) for heritage and urban documentation.

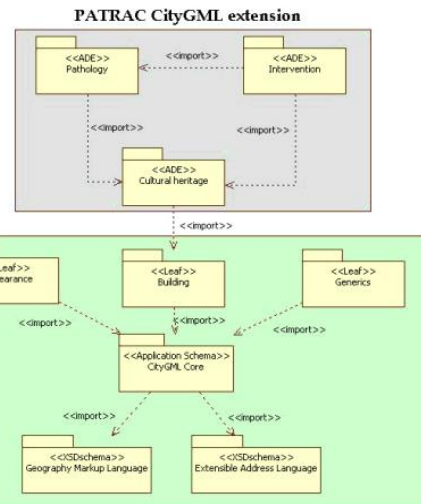


Figure 10 : Caption of a GIRAPIM CityGML extension source by F. J. Delgado et.al, (2010)

CONCLUSION

3D city model is a method to be real environment change to virtual 3D environment and can solve any problem in heritage preservation. By implement of LoDs, the 3D city model can be partition in different scale to analysis and management purpose. Meanwhile, CityGML have give beneficial for researchers to create 3D city model for its supported file. The ADE from CityGML extend have give advantages for semantically modelling detailed heritage house and the attributes that will be interoperable among many software application.

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