# Naming objects in BIM: A convention and a semi-automatic approach

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**Abstract**

A consistent and easily recognizable name is the primary identifier of an object in building information modeling (BIM). Existing naming conventions vary significantly from one to another, and require extensive manual work that is often tedious and error-prone. This study seeks for (a) developing a standardized naming convention for BIM objects, and (b) devising a semi-automatic naming approach for saving the manual work. In the proposed naming convention, each segment is included by referencing BIM standards and considering BIM users' actual needs; and the semi-automatic approach is formalized for both completed and ongoing BIM models. Validated by a control experiment and feedbacks from the project manager and BIM engineers of a real-life project, this research can be immediately applied to realize standardized BIM object names. This study also generates practical implications for BIM-based project management, where standardized BIM object names are required for supporting object identification and information incorporation throughout a project life cycle.

**Keywords:** Building information modeling; data interoperability; naming convention; Information technologies.

**Introduction**

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Building information modeling (BIM) has revolutionized the way in which buildings are conceived, designed, constructed, and operated (Hardin and McCool 2015). In a BIM model, all objects (e.g., wall and window) are augmented with both geometric and non-geometric parameters (Pratt 2004). Among these parameters, the name is the primary identifier of a BIM object (Taylor 2007, Duddy et al. 2013, Chen et al. 2015), which is frequently used to link the object with relevant information in other data carriers such as Excel files or Word files throughout a project life cycle (Goedert and Meadati 2008). By doing so, project managers can truly use BIM to support process control (Song et al. 2012), facility management (Teicholz 2013), design assessment (Cidik et al. 2010), indoor navigation (Isikdag et al. 2013), safety checking (Zhang et al. 2013), energy simulation (Cao et al. 2014) and so on. Lacking standardized BIM object names would make it onerous for BIM users to retrieve information (Gandhi and Jupp 2014), and cause coordination difficulties and confusions amongst stakeholders (Taylor 2007, Shafiq et al. 2012).

In light of the importance of BIM object names, several naming conventions have been developed over the past years, though, not yet been widely used by practitioners. A primary barrier therein could be an insufficient analysis on the naming-convention segments regarding the practitioners' actual needs. Moreover, naming objects in BIM in a consistent and structured manner often involves extensive manual work that can be incredibly tedious and error-prone, particularly when construction projects nowadays become increasingly complex (Williams et al. 2014). This research thus aims to (1) develop a standardized naming convention for BIM objects that considers practitioners' requirements and meanwhile is largely compatible with prevailing BIM standards; and (2) devise a semi-automatic approach to naming BIM objects based on the proposed naming convention.

46 This paper starts with a review of existing naming conventions and naming approaches. The

47 processes of developing a viable naming convention and devising a semi-automatic naming

48 approach are subsequently introduced. Next, validation of the naming approach is presented.

49 Finally, concluding remarks are provided by highlighting implications of this paper and

50 suggesting future research direction.

51

**Literature Review**

52

53 A structured BIM object naming convention is important for BIM users to easily understand

54 and recognize denominated BIM objects (McPhee 2014, Barbosa et al. 2016). Existing BIM

55 software such as Autodesk Revit, however, only labels BIM objects with default serial

56 numbers or numerical identifications (IDs) that are meaningless to users. Facing this issue,

57 some BIM standards (e.g., DOA/DSF 2009, National Building Specification [NBS] 2014)

58 and scholarly papers (e.g., Pavan et al. 2014, Merschbrock and Munkvoid 2015) have

59 suggested standardized naming conventions. These suggestions, nevertheless, have not

60 provided sufficient details on the segments to be included in the names, and not attached

61 adequate attentions to practical requirements of BIM users.

62

63 Previous studies have also striven to facilitate naming objects when developing the BIM

64 model. For example, Eastman (2009) laid out a review tool for assessing whether objects in a

65 model have proper names or not. Venugopal et al. (2012) suggested that rules should be

66 written to check BIM object names. These efforts, unfortunately, only focused on *ex post*

67 *facto* checking instead of *ex ante* assurance. Alternatively, some add-on tools enabling

68 information exchange between BIM software and external files could be used to name BIM

69 objects. For instance, BIMLink can export a list of BIM objects into an Excel file.

70 Practitioners then can input a connotative name of each object in Excel, and import the file

71  back to BIM. Such approach, though proving the importance of BIM object names, involves

72  reiterative file exporting and importing, and still demands considerable manual work for

73  searching and linking the information contained in BIM and its corresponding external file.

74  Therefore, without an efficient and easily implemented naming approach, it would be

75  difficult to assign standardized, connotative names to BIM objects, and in turn, to make a

76  BIM model truly informative.

77

78  **Research Design and Methods**

79  This research was conducted via three steps (cf. Fig. 1). In the first step, the authors reviewed

80  the existing naming conventions appeared in various BIM standards, and interviewed

81  representatives of the Architecture, Engineering, and Construction (AEC) industry to collect

82  their opinions on BIM object naming conventions. As a result of Step 1, a viable naming

83  convention was developed. In the second step, each segment of the proposed naming

84  convention was analyzed to identify whether it could be automatically acquired from BIM or

85  needed to be input manually. The prerequisites for ensuring the quality of automatic

86  acquisition were also analyzed. These analyses helped to devise the semi-automatic naming

87  approach. In the third step, a control experiment was performed to quantitatively validate the

88  devised semi-automatic naming approach. Besides, the proposed naming convention and the

89  semi-automatic naming approach were introduced in a real-life project for analyzing their

90  pros and cons.

91                           <<Please insert Fig. 1 here>>

92

93  **Towards a naming convention for BIM objects**

94  After screening 22 BIM standards published worldwide and written in English, the authors

95  discovered that eight standards are particularly related to naming objects in BIM. They are

96 *BIM Guidelines and Standards for Architects and Engineers* (DOA/DSF 2009), *E/A Design*

97 *Division BIM Standard Manual* (Port Authority of NY & NJ Engineering Department

98 [PANY&NJED] 2012), *Department of Design + Construction (DDC) - BIM Guidelines*

99 (DDC 2012), *NBS BIM Object Standard* (NBS 2014), *Australian and New Zealand Revit*

100 *Standards* (Australian and New Zealand Revit Standard Committee [ANZRSC] 2012), *BIM-*

101 *Mechanical, Electric, Plumbing Australia Practice* (Air Conditioning Mechanical

102 Contractors Association [AMCA] 2014), *AEC (UK) BIM Protocol* (AEC UK 2012), *BIM*

103 *Library Components Reference* (Hong Kong Housing Authority [HKHA] 2010). A total of ten

104 naming-convention segments were regulated by the BIM standards reviewed, which are *type*

105 (100%), *description* (75%), *function* (50%), *sequential number* (50%), *manufacturer* (50%),

106 *location* (37.5%), *role* (12.5%), *item code* (12.5%), *level of detail* (12.5%), and *property*

107 (12.5%). The percentage in brackets denotes how many percent of the standards have

108 regulated that specific segment.

109

110 In order to gather opinions on name conventions from practitioners, the authors of this paper

111 have interviewed 21 experts from 7 AEC firms in Hong Kong, including one private

112 developer, one public developer, two leading main contractors, one design film, one principal

113 supplier, and one global BIM software vendor. All interviewees possessed 3 years' or more

114 experience of using BIM.

115

116 The interviewees were asked open-ended questions individually. Questions were organized

117 into two parts, viz.,11.2 and Part II (*P2*) was to investigate their requirements for information

118 segments to be included in a BIM object name. The *P1* data were transformed into weighting

119 using principal component analysis (PCA) in SPSS. Given each interviewee's weighting and

120 similar to the method used in the survey on BIM standards, the *P2* data were organized

121 according to the weighted percentage assigned to each naming-convention segment

122 mentioned by the interviewees. A total of nine segments were suggested. In descending order

123 of the weighted percentage, they are *type* (100%), *location* (87.07%), *sequential number*

124 (76.19%), *function* (72.79%), *description* (49.66%), *designer* (14.29%), *manufacturer*

125 (9.52%), *item code* (6.80%), and *level of detail* (4.76%). It means that all the interviewees

126 opted in the importance of object 'type', 87% on 'location', and so on.

127

128 Segments that were agreed as being important were included into the proposed naming

129 convention, while those with lower importance were excluded to avoid the redundancy of the

130 BIM object names. The *designer*, *project name*, *role* and *property* were only mentioned in

131 one of the two surveys and hence were not included. Although *manufacturer* was regulated

132 by half of the BIM standards reviewed, the same was not true in the survey of AEC

133 stakeholders (the view was that it would clutter up the BIM object name). The *item code* and

134 *level of detail* were considered less important in both surveys, and so were dropped. As a

135 result, five segments were incorporated in the proposed naming convention:

136          *<Function>_<Type>_<Location>_<Sequential number>_< Description>*

137 (1) *Function* gives the general classification of a BIM object (e.g., window, wall, or door).

138 (2) *Type* provides a detailed specification to distinguish objects having the same function

139      (e.g., sliding door or pivot door).

140 (3) *Location* specifies where the object is located in the model. For objects that are not

141      assigned to a specific level or space, this segment will be set to a null value.

142 (4) *Sequential number* refers to numbers in sequential order. It will be added when other

143      segments in the names of any two or more objects share the same values.

144 (5) *Description* refers to supplementary information about the object. This may vary among

145      projects and modelers, and thus could be considered as optional.

146

**Developing the semi-automatic naming approach for BIM**

148 By applying the convention above, names of BIM objects become more meaningful and can

149 serve as efficient identifiers. Nevertheless, to name the objects, including their detailed

150 segments, is quite tedious, time-consuming, and prone to errors. Therefore, an automatic

151 approach for naming BIM objects is desired. It has to be judged whether a segment can be

152 automatically acquired from BIM, or have to be input manually. By examining the

153 mainstream BIM software, it is encouraging to discover that values of three segments of the

154 proposed naming convention, viz., *function, type,* and *location*, can be obtained automatically

155 when a BIM is developed, e.g., by retrieving BIM objects and putting them in place, if these

156 values are preset in the software or added by BIM users. The *sequential number* can also be

157 assigned automatically in an ascending numerical order in case of multiple identical objects

158 (e.g., three windows) in one cluster (e.g., in a single wall). By contrast, *description* has to be

159 manually added, edited, or deleted according to different requirements of different projects

160 and stakeholders.

161

162 Based on the analyses, a semi-automatic naming approach is developed for both a completed

163 and ongoing BIM (cf. Fig. 2). Here, 'completed' means that all information and details of the

164 model have been set and no further changes are necessary; 'ongoing' means that the model is

165 being developed and may change. For both, the first step is to specify the format of each

166 naming-convention segment. The model should then be properly prepared to ensure that the

167 name of each object contains the correct information in the correct format. The next step is to

168 acquire the information for each segment by following a logical sequence. Finally, the

169 collected information is combined to give the object name, and *description* will be manually

170 added if required. When a BIM object is changed or moved in an ongoing BIM, its name

171  should also be updated. Fig. 2 shows three scenarios for naming changed or moved objects.

172  In Case 1, the original object is replaced by a new one, and the entire naming process is

173  repeated for this new object. In Case 2, the original object is moved, so the information of

174  *location* is re-acquired for updating the *location* segment in its name. In Case 3, only

175  *description* need to be added or removed manually with the other information remaining

176  unchanged. All changes in objects' names need to be shared with all stakeholders in a timely

177  manner to avoid misunderstandings or errors caused by inconsistent naming. The semi-

178  automatic naming approach was programmed as an add-on tool for Autodesk Revit. This is

179  called 'semi-automatic' since some of the segments of a name still need manual inputs.

180  <<Please insert Fig. 2 here>>

181

182  **Validation and discussion**

183  To validate the effectiveness of the proposed naming convention and the 'semi-automatic'

184  add-on tool, a succession of research activities, primarily involving a control experiment in

185  an education environment and feedback collection from the industry, were conducted.

186

187  *Control experiment*

188  The experiment was carried out in a university BIM lab that provided high-specification

189  desktop computers with the same configurations and the BIM software Autodesk Revit

190  2015®. A BIM model of a high-rise public housing project was developed. The experimental

191  task was to name the 191 prefabricated components of a typical floor in the BIM model.

192  Specifically, experiment participants were requested to fill the 'Object Name' among the

193  many properties of a component (cf. Fig. 3).

194  <<Please insert Fig. 3 here>>

195

196     A random sample of 32 Year-3 undergraduates participated in the experiment. They were all

197     majored in construction and engineering. As most of them would probably work in the AEC

198     industry in the near future, they were considered more similar to AEC practitioners than

199     students taking other majors. The 32 participants were introduced to the subject project and

200     the naming convention to be used (e.g., PF_TX8_2/F_2_M1, where 'PF' denotes for 'precast

201     façade' [function], 'TX8' is the façade shape [type], '2/F' refers to 'the second floor' [vertical

202     location], '2' refers to 'the second room' [horizontal location], and 'M1' is the mold type

203     [description]), and were trained in basic operations of naming objects in Autodesk Revit

204     2015®. Then, the students were divided into two groups of equal size, and the experiment

205     was conducted in four rounds. In the first two rounds, the control group was asked to

206     manually input the name of each prefabricated component, as most of the existing practices

207     do. In contrast, the experimental group was asked to use the add-on tool that was

208     programmed to implement the semi-automatic approach (see Fig. 4). Then, the two groups

209     switched tasks, and two further rounds of experiments were conducted. Therefore, each

210     subject student could experience both manual input and the semi-automatic approach.

211                                      <<Please insert Fig. 4 here>>

212

213     The control group and the experimental group began tasks at the same time. Participants

214     needed to alert the researchers once they finish their tasks on hand so the time they used is

215     recorded and the accuracy rate was calculated instantly by dividing the number of correctly

216     named objects by the total number of BIM objects. As shown in Table 1, by using the semi-

217     automatic naming approach, the average time for completing the subject assignment could be

218     shortened by 58.42%, and the average accuracy rate can be increased by 9.36%. This saving

219     could be much more phenomenal in real-life BIM applications wherein a single floor could

220     involve numerous objects.

221                                                                 <<Please insert Table 1 here>>

222

### Feedbacks from the industry

224    By taking advantage of a government-funded research for applying BIM in a construction

225    project, the proposed naming convention and the semi-automatic naming approach were

226    introduced to the project manager and two BIM engineers. In the original BIM model of the

227    subject project, all objects did not have standardized names. Considerable manual work hence

228    was required for identifying individual BIM objects and matching them with the information

229    in the enterprise information system (e.g., a logistic and supply chain management system) or

230    other data carriers (e.g., a spreadsheet).

231

232    After specifying the format of each segment in the proposed naming convention and the BIM

233    software used in this project, the add-on tool was provided to the three interviewees to

234    implement the semi-automatic naming approach. Subsequently, they were invited to link BIM

235    objects with their counterparts in an Excel file by using object names as identifiers. The

236    usefulness of the semi-automatic naming approach was almost instantly confirmed by the

237    interviewed BIM engineers. Besides, the project manager reflected that although extra time

238    was spent for preparations such as checking the type of BIM objects, the efforts could be

239    rewarded at later stages. Based on the proposed naming convention, an object name not only

240    ensures quick, unique identification of a BIM object, but also facilitates information

241    interoperability, which was key for conducting downstream analyses within BIM applications.

242

243    In addition to the favorable responses, interviewees expressed their concerns about the

244    proposed naming convention. Firstly, it might be difficult for all stakeholders to follow the

245    same naming convention without the leading role of the client or the main contractor.

246 Secondly, the project manager expressed that the adoption of the naming convention would

247 be affected by the extent to which BIM is truly implemented in a construction project. If the

248 model was for 3D representation only, the naming convention would be less necessary. In

249 contrast, to truly harness the power of BIM, succinct yet informative names of BIM objects

250 become paramountly important.

251

252 **Concluding remarks**

253 As the most direct identifier of an object in BIM, a consistent and easy-to-recognize name is

254 necessary for object identification and information interoperability. Without such name

255 convention in place, it is almost suspicious to claim harvesting the full benefits of BIM in

256 construction projects. This research, by developing a BIM object naming convention and

257 encapsulating it in a computerized 'add-on' tool, has both immediate practicality and long-

258 term significance. Firstly, a strategy is proposed for developing a naming convention that is

259 compatible with prevailing BIM standards meanwhile meets practitioners' actual needs. By

260 following this strategy, the naming convention, comprising five segments, can be easily

261 interpreted by architects, engineers, contractors, and other stakeholders. Secondly, the

262 devised semi-automatic naming approach can save BIM modelers tremendous amount of

263 manual work when inputting the name of tens of thousands of objects in a BIM model. Future

264 research could be undertaken towards enhancing the proposed naming approach by exploring

265 semantics on the depiction of object types in BIM, for ultimately enabling an automatic

266 translation of different depictions into a uniform one.

267

271

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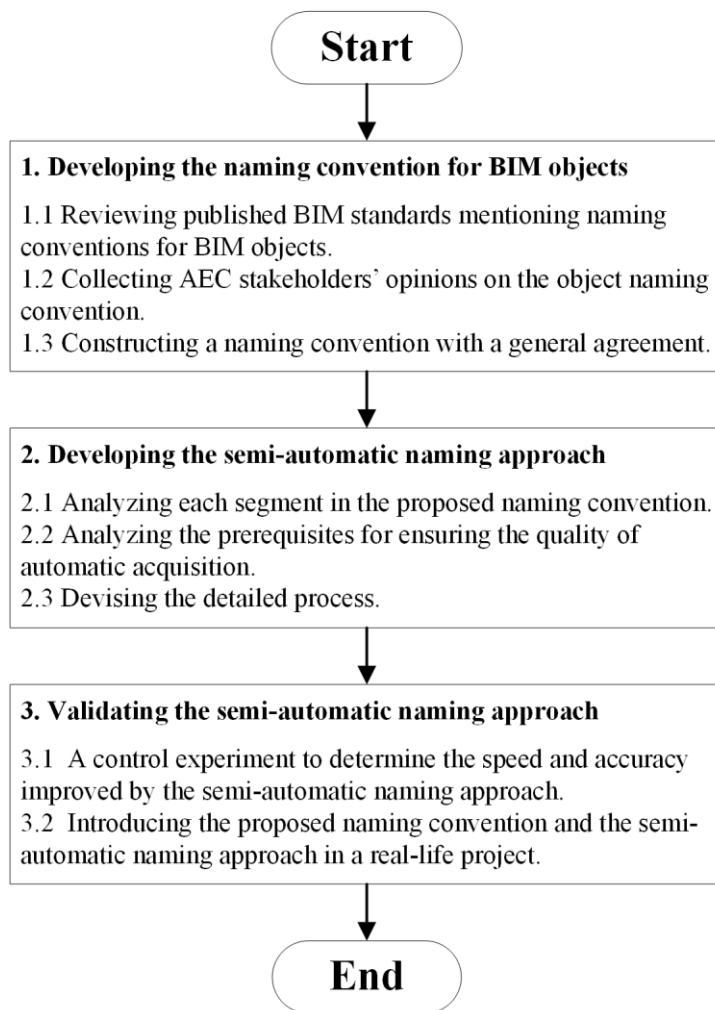339   *Construction Applications of Virtual Reality*, 40-46.

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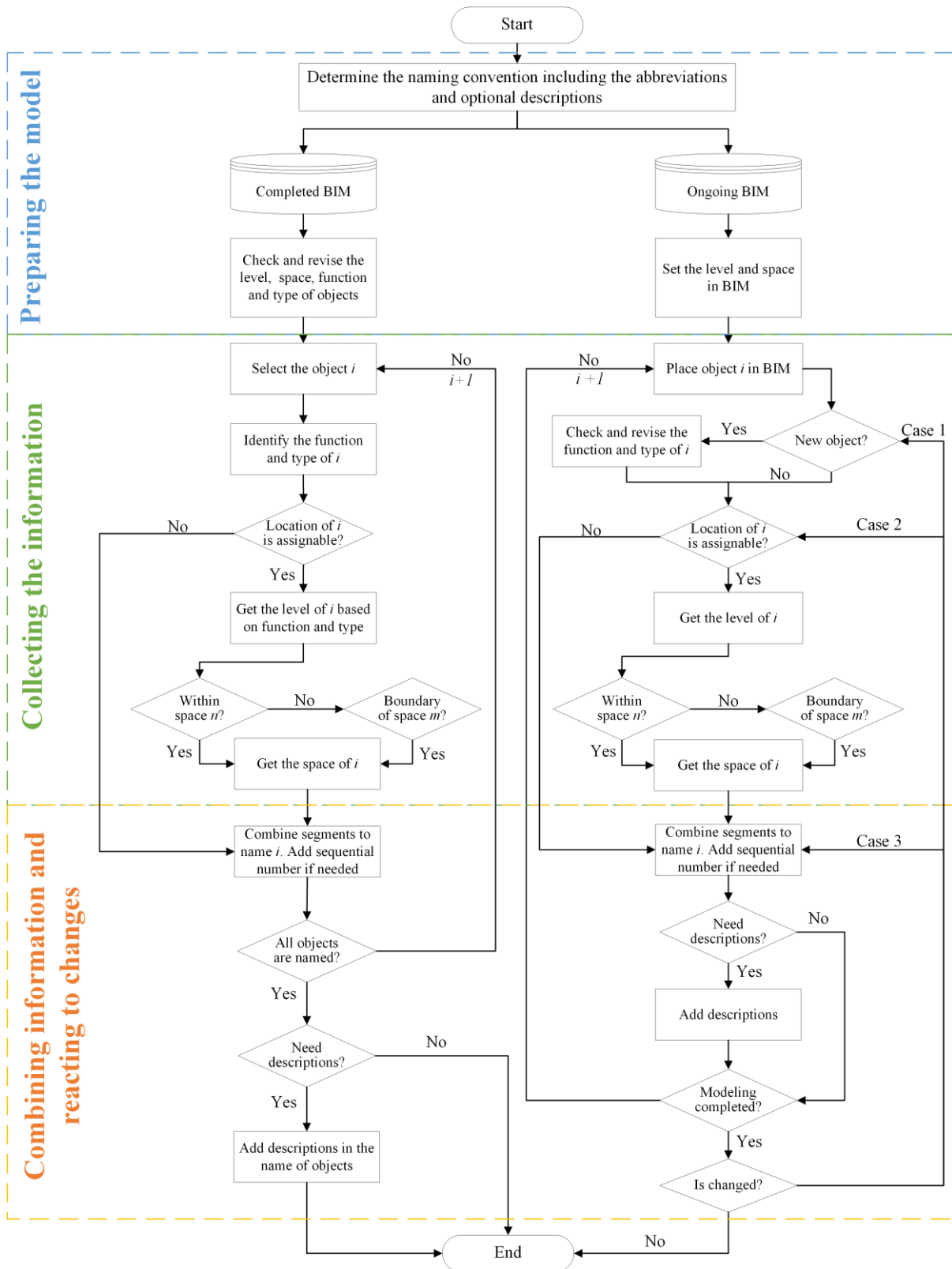**Fig. 1** Research methods

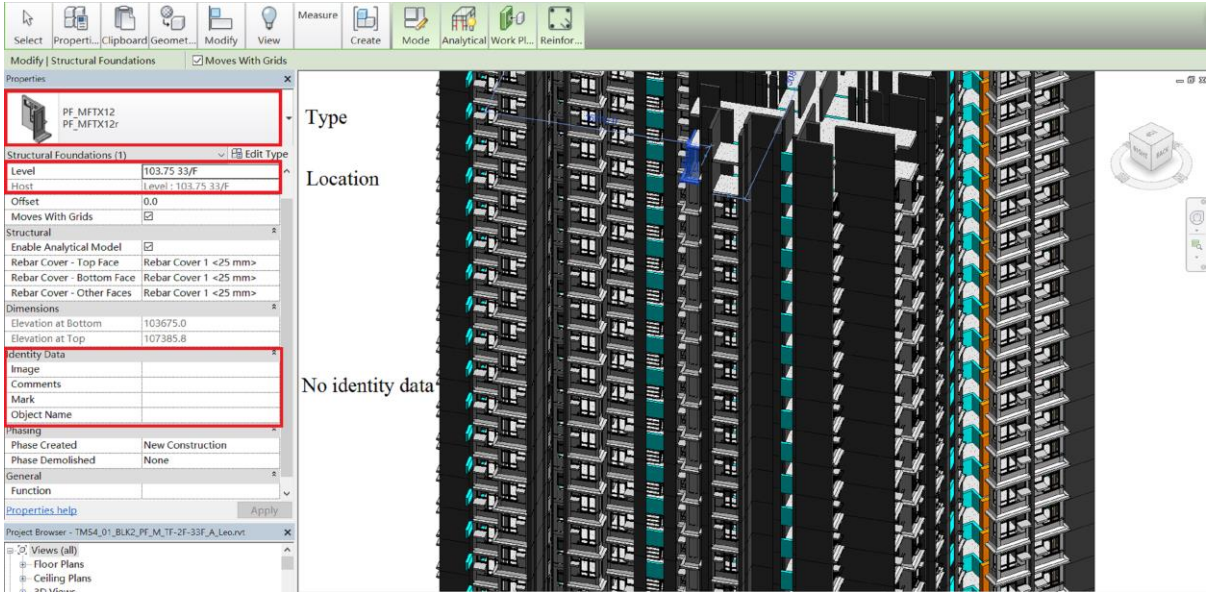**Fig. 2** The semi-automatic naming approach

**Fig. 3** The BIM model for the control experiment
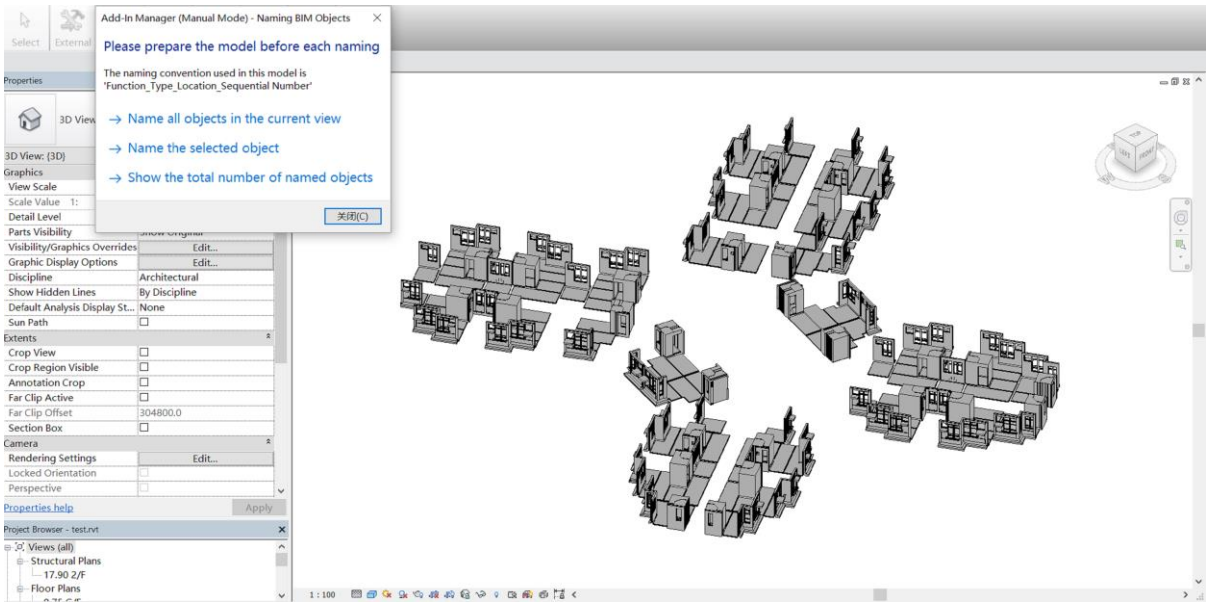


**Fig. 4** Screenshot of the add-on tool

Table 1. Results for time spent and accuracy rate.

| Group | Time spent (min) | | | | Accuracy rate (%) (Total = 191) | | | |
|---|---|---|---|---|---|---|---|---|
| **Experimental (N=16)** | Maximum | Minimum | Mean | SD | Maximum | Minimum | Mean | SD |
| | 37.79 | 28.76 | 33.27 | 2.9 | 97.91 (187) | 94.24 (180) | 96.16 (183.66) | 2.22 |
| **Control (N=16)** | Maximum | Minimum | Mean | SD | Maximum | Minimum | Mean | SD |
| | 99.43 | 61.45 | 80.02 | 11.11 | 91.10 (174) | 83.77 (160) | 87.16 (166.47) | 4.38 |