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Building Capabilities in Complex Environments

CitA BIM Gathering 2017, Croke Park, November 23rd & 24th, 2017

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Automated Compliance Checking: A Visual Programming Approach

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- MSc. BIM Management DIT Research Paper –
  - By Jonathan Reinhardt & Supervised by Malachy Matthews
- Automated Floor Area Compliance
  - Schedule updates automatically
  - Minimum rework & measuring
- Architects Practice – Planning & Further Information Stages
- 178 Housing Development
- Estimated 60-70% Less time spent on floor area schedule & checking

1. Introduction

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Research Motivation

- Working in design offices and seeing first hand the manual processes.

- *…..human interpretation causes inconsistencies in applying Building Regulations (Solihin & Eastman, 2015). Producing, updating and quality assuring such processes is inconsistent and unreliable (Preidel & Borrmann, 2016).*

Research Objectives

- Establish the problem of manual checking tasks.
- Propose a solution through development.
- Implement the solution and evaluate in practice.

Source: Design Science Methodology

Research Methodology

- *General Methodology of Design Research - (Von Alan et al., 2004).*

- Proposed methodology for BIM research by Dermot Kehily DIT, CITA 2015.

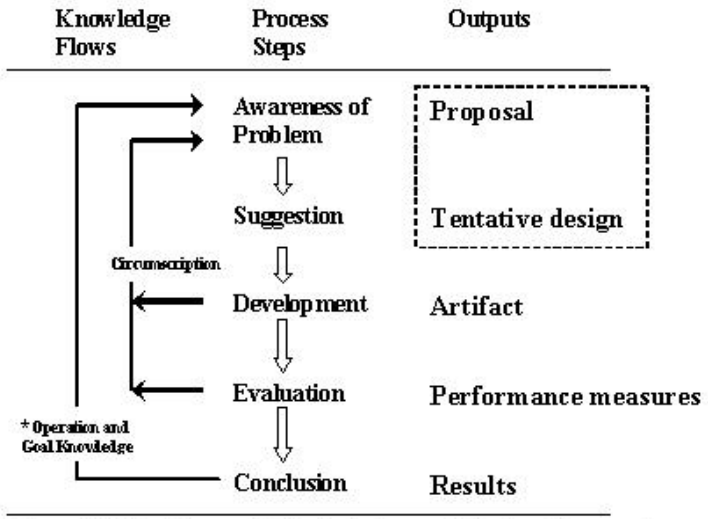
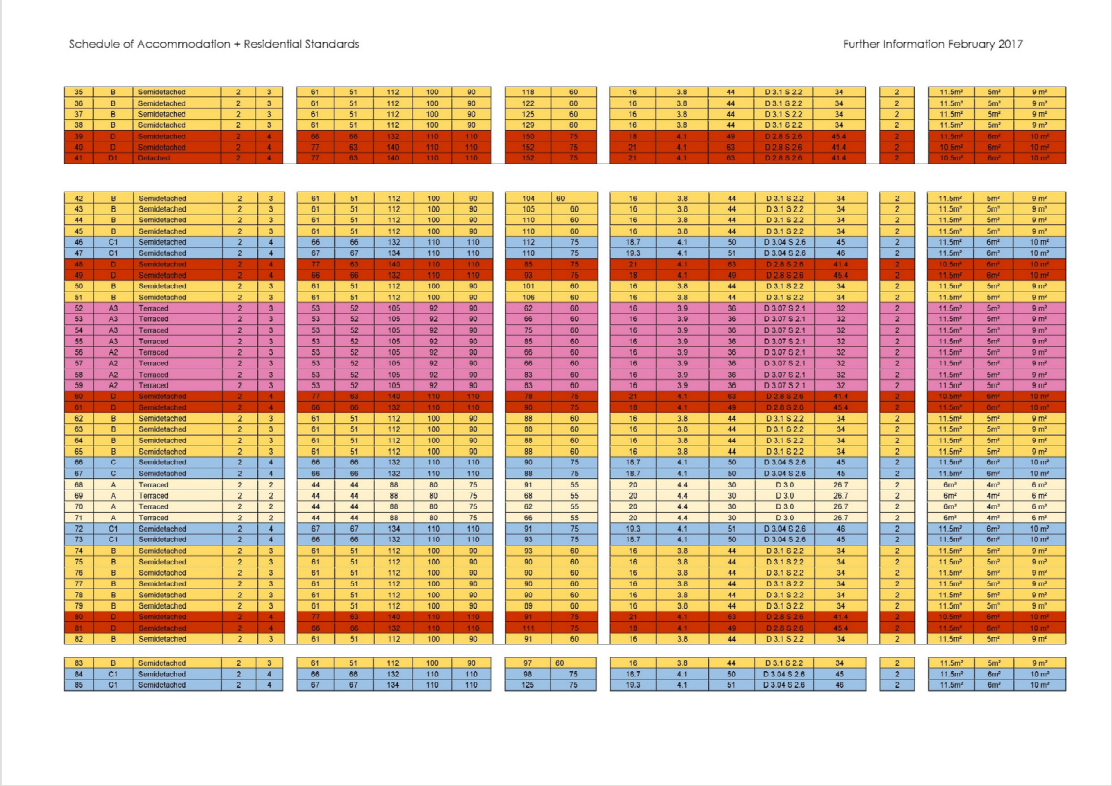


Figure 5. The General Methodology of Design Research

2. Compliance Checking Practice - Challenges & Benefits

Compliance Checking Practice - Challenges

- Time
- Error in information
- Rework



Schedule of Accommodation + Residential Standards — Further Information February 2017

Compliance Checking Practice - Benefits

- Streamline business approaches in the construction industry
- Improve application turnaround time.
- Increase quality and productivity.
- Reduce the burden of compliance with regulations.
- Provide feedback to assist Architects and clients in designing buildings.

Source: Singapore BCA Corenet

3. Dynamo (Visual Programming Software)

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Why Dynamo ?

- Open Source Software (Democratic)
- Included in Revit as a free plugin
- Some knowledge of how to use
- Conceptual graph

Dynamo

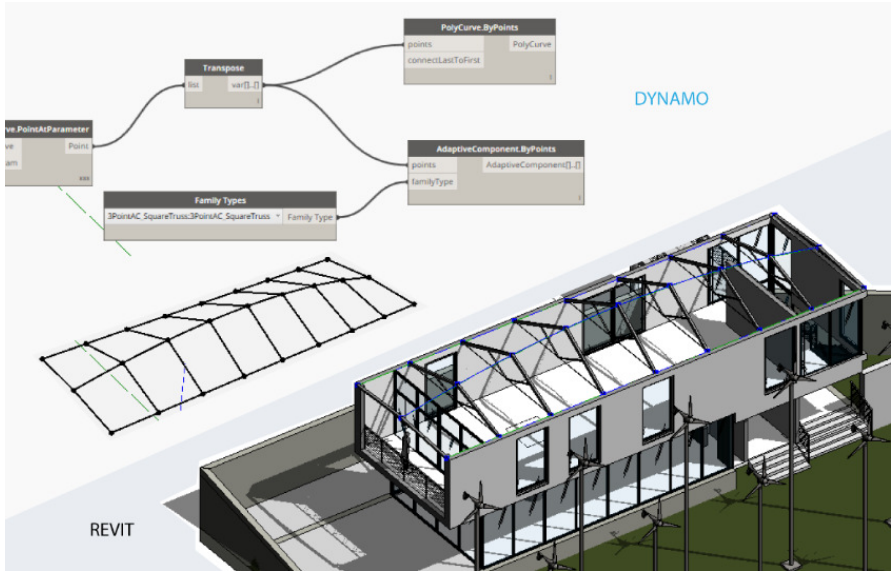
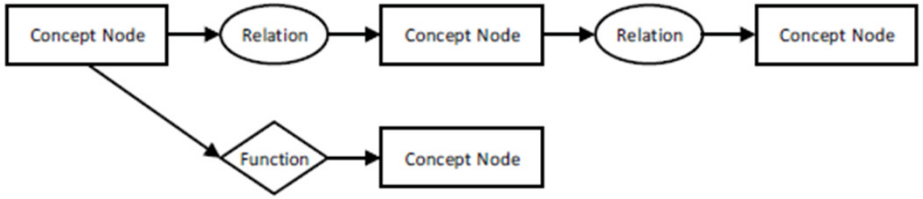


Figure 4 - Conceptual Graph Method (Solihin & Eastman, 2015)



Other Visual Programming Tools

- Flux
- Grasshopper

Flux.io

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4. Conceptual Graph Method & KBIM Study

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The process adds a constraint or rule of the building regulations through nodes and relations. The CORENET system in Singapore applied the same rule method….(Solihin, Shaikh, Rong, & Khee, 2004).

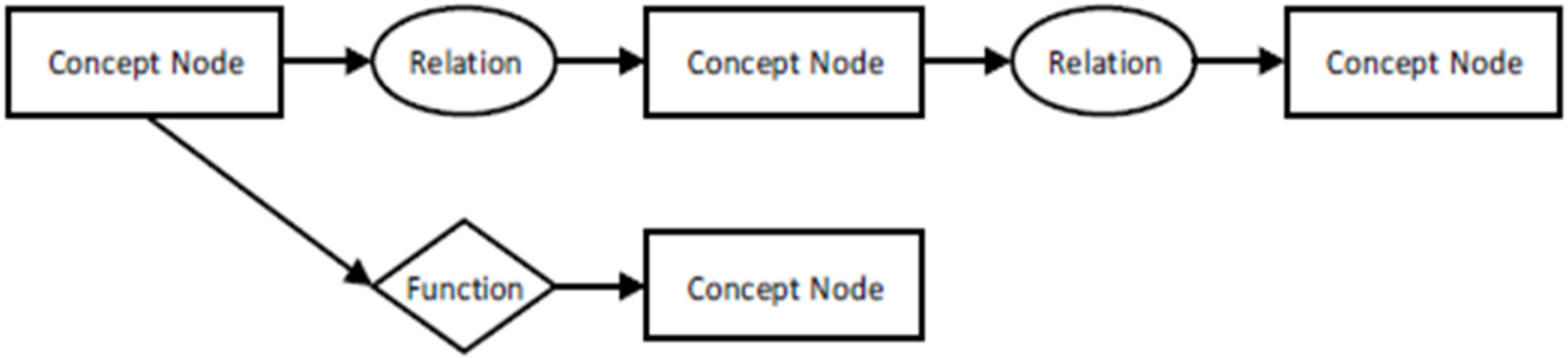

Figure 4 - Conceptual Graph Method (Solihin & Eastman, 2015)

A study in Korea “KBIM Assess” to merge compliance checking with Planning System.

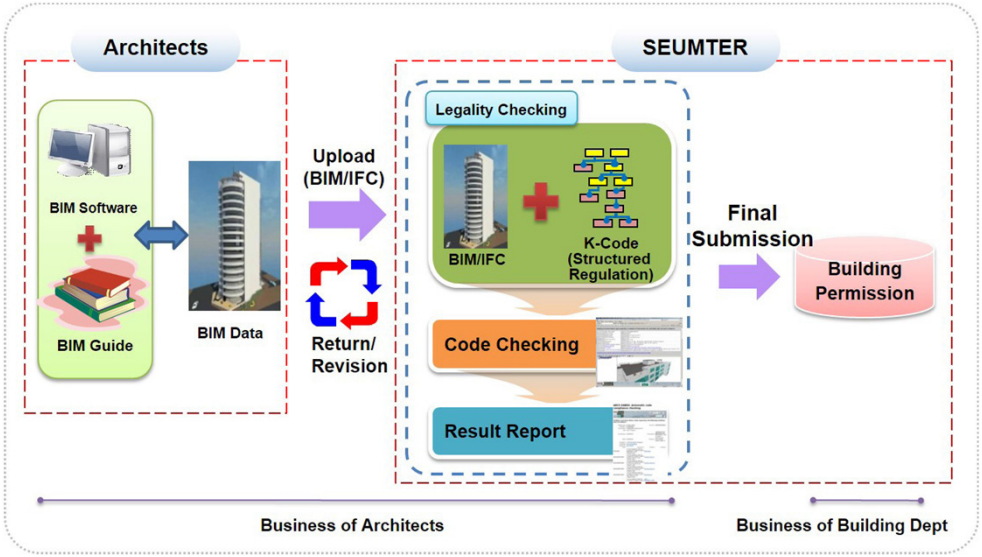

Figure 3 - Process for the Legality System Based on Open BIM - (Choi & Kim, 2015)

Check	Apply	Exception	Select	Applies	Select	Applies	Applies	Requirement
U-Value	Central district (example)	Garages, machine rooms, buildings without established heating or cooling equipment	Fabric	External wall	Living room	When directly facing outdoor air		Lower than 0.47
		Building in which there is no energy saving effect (such as factory, warehouse equipment, excreta treatment plant)				When indirectly facing outdoor air		Lower than 0.64
				Ceiling or roof	Living room (top story)	When directly facing outdoor air		Lower than 0.29
						When indirectly facing outdoor air		Lower than 0.41
				Floor	Living room (lowermost story)	When directly facing outdoor air	Floor heating	Lower than 0.35
							Except floor heating	Lower than 0.41
						When indirectly facing outdoor air	Floor heating	Lower than 0.52
							Except floor heating	Lower than 0.58
				Side wall	Apartment house			Lower than 0.35
				Story floor	Apartment house		Floor heating	Lower than 0.81
							Except floor heating	Lower than 1.16
			Window, door		Apartment house	When directly facing outdoor air		Lower than 3.00
					Except apartment house			Lower than 3.40
					Apartment house	When indirectly facing outdoor air		Lower than 4.30
					Except apartment house			Lower than 4.60

Figure 1 - KBIM Lookup Table (Choi & Kim, 2015)

5. Conduct the Data Collection: Surveys

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Survey Results

- BCAR
- Floor Area Compliance
- Planning Standards
- Fire Regulations
- Accessibility Regulations

6. Global Compliance Automation - Review

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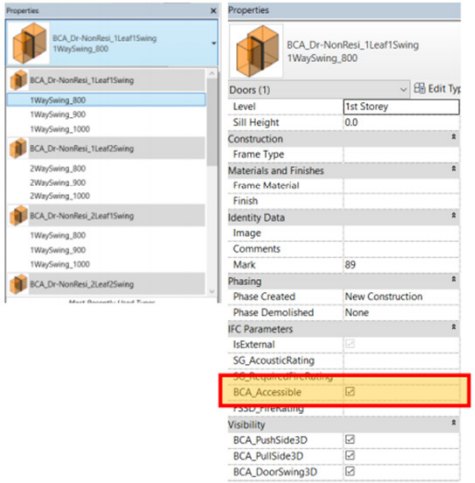
- **Singapore BCA BIM E-Submission (2016)**

Accessible Door

Click Architecture tab ➤ Build panel ➤ Door.

In the properties type selector, select any *BCA_Dr*



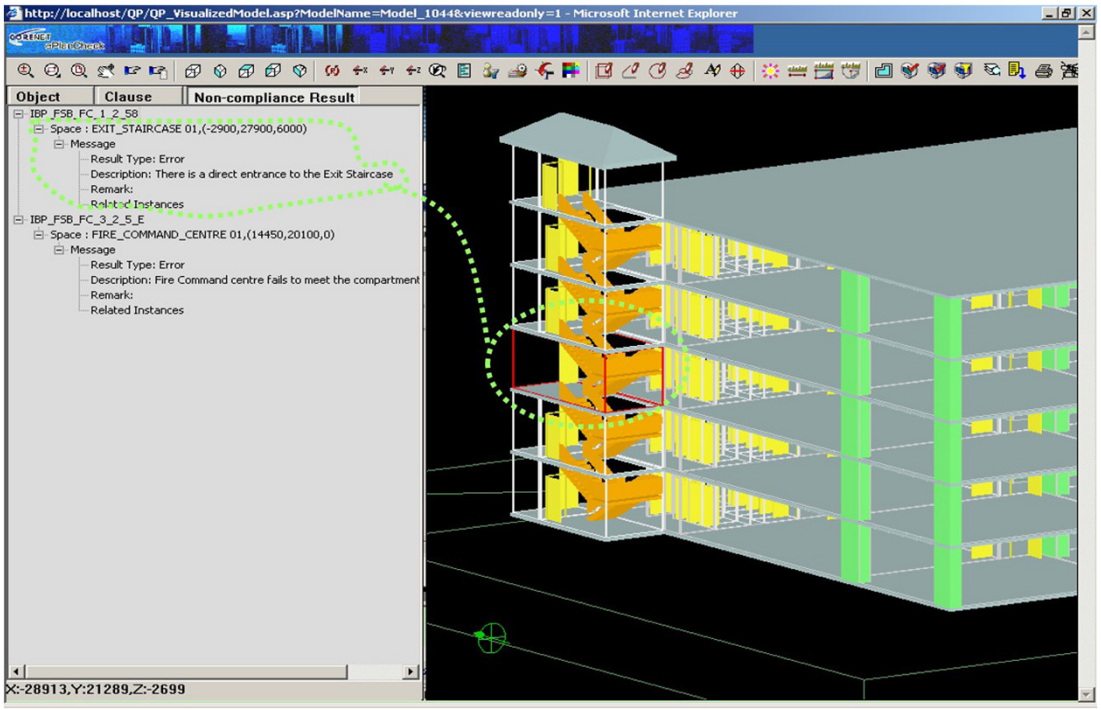
Note: *Accessible doors shall be placed on accessible areas.*

Tips: *BCA_Dr families and types are limited to generic door types for the purpose of accessibility.*

Click on the wall to place a door.

Note: *By default, all doors are accessible when placed. Uncheck* ***BCA_Accessible*** *if needed.*

- **E-Plan Check Singapore (2005)**



- **Australia DesignCheck (2006)**
  - Object based models to determine “Design for access and mobility”
- **ByggSøk Norway (2009)**
  - IFC models for planning & zoning regulations & accessibility
  - Based on Singapore checking system
- **USA International Code Council SmartCodes**
  - Upload model, returns XML or Excel table like feedback to designer

- **US GSA Project (2007)**

Spatial information is identified. This information is tagged to IFC parameters and linked to compliance standards of minimum floor areas.

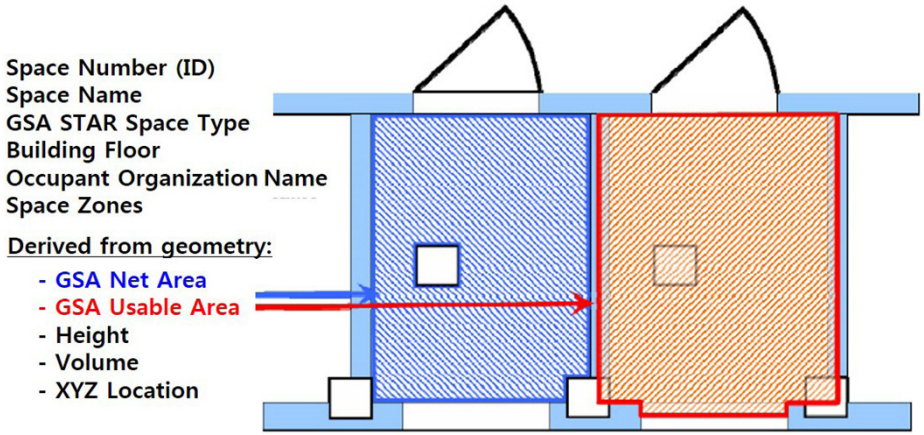


Figure 12 - Definition of Spatial Information According to GSA Guidelines (GSA, 2006)

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7. Solution Testing

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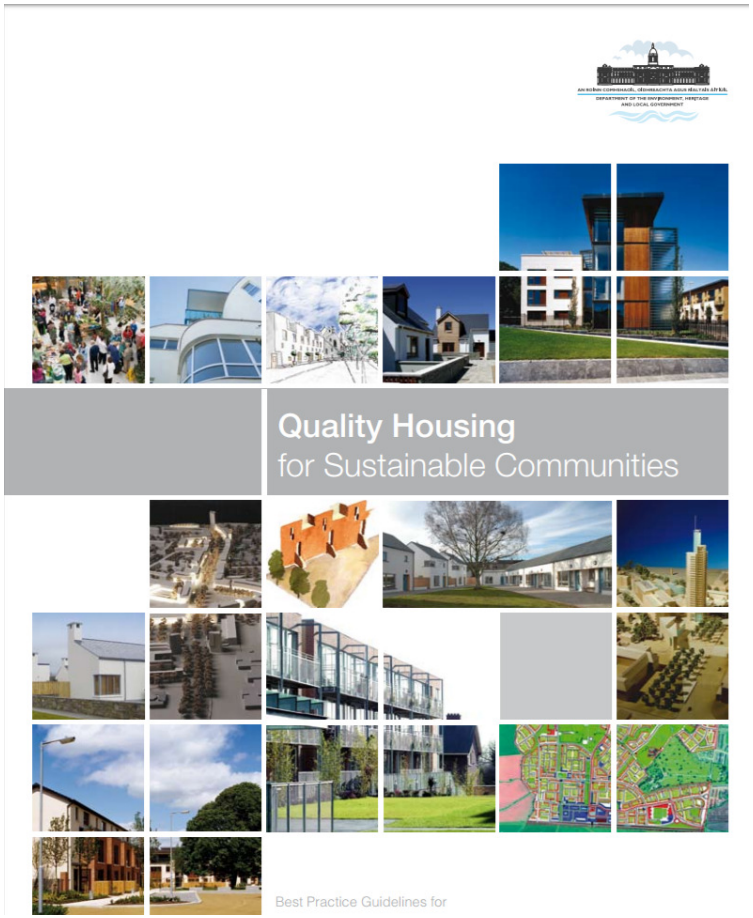
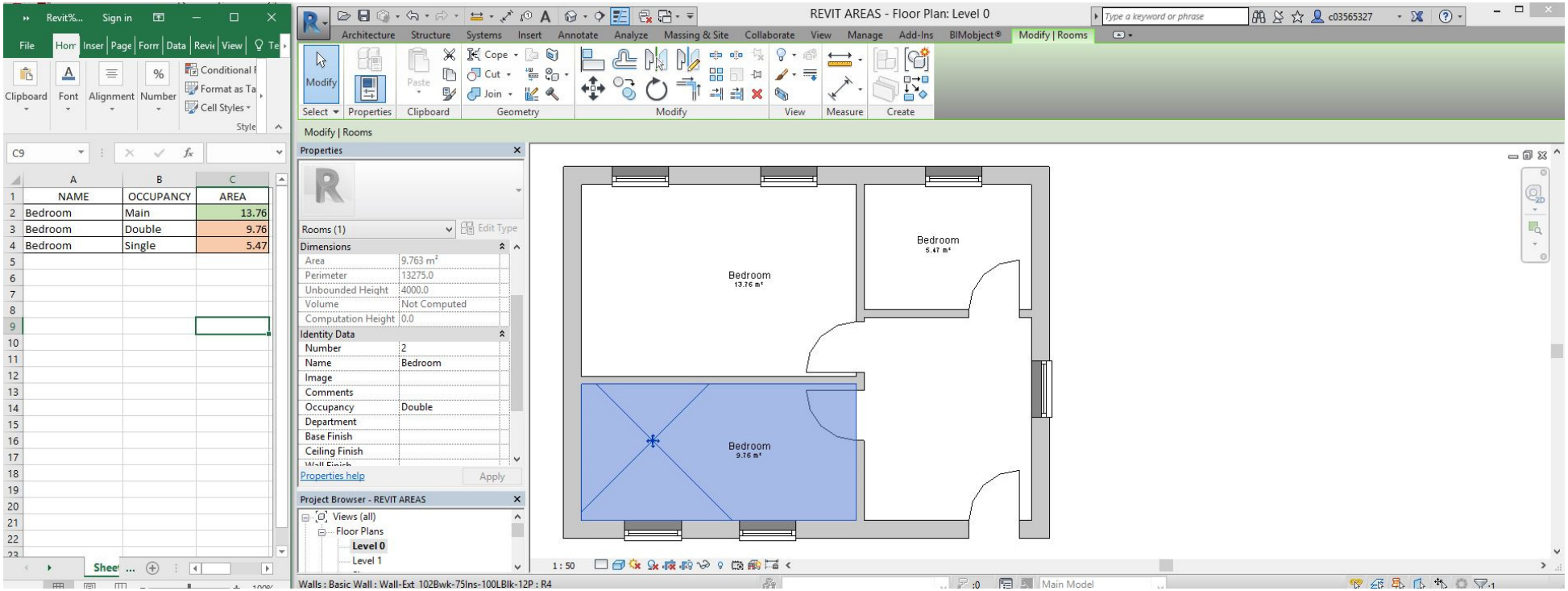
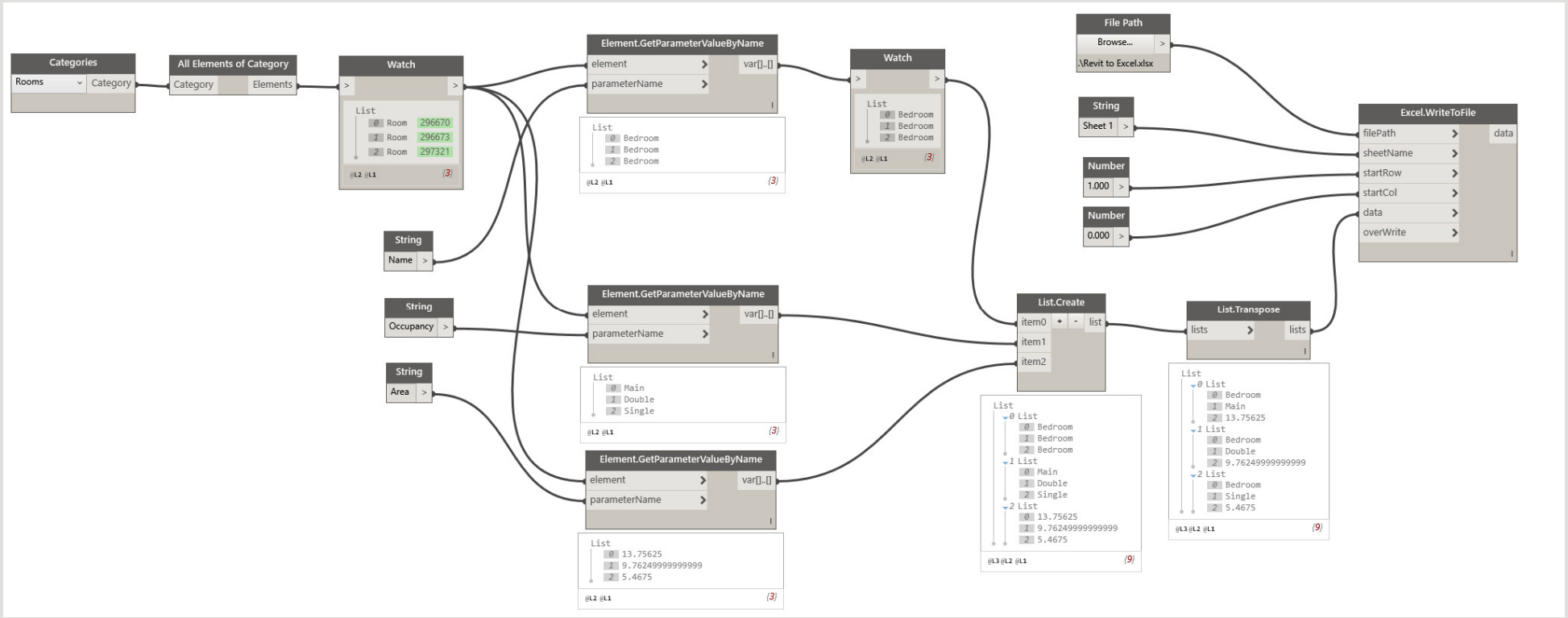


DWELLING TYPE	TARGET GROSS FLOOR AREA	MINIMUM - MAIN LIVING ROOM	AGGREGATE LIVING AREA	AGGREGATE BEDROOM AREA	STORAGE
	(m^2)	(m^2)	(m^2)	(m^2)	(m^2)
Family Dwellings - 3 or more persons					
4BED/7P House (3 storey)	120	15	40	43	6
4BED/7P House (2 storey)	110	15	40	43	6
4BED/7P House (1 storey)	100	15	40	43	6
4BED/7P Apartment	105	15	40	43	11
3BED/6P House (3 storey)	110	15	37	36	6
3BED/6P House (2 storey)	100	15	37	36	6
3BED/6P House (1 storey)	90	15	37	36	6
3BED/6P Apartment	94	15	37	36	10
3BED/5P House (3 storey)	102	13	34	32	5
3BED/5P House (2 storey)	92	13	34	32	5
3BED/5P House (1 storey)	82	13	34	32	5
3BED/5P Apartment	86	13	34	32	9
3BED/4P House (2 storey)	83	13	30	28	4
3BED/4P House (1 storey)	73	13	30	28	4
3BED/4P Apartment	76	13	30	28	7
2BED/4P House (2 storey)	80	13	30	25	4
2BED/4P House (1 storey)	70	13	30	25	4
2BED/4P Apartment	73	13	30	25	7
2BED/3P House (2 storey)	70	13	28	20	3
2BED/3P House (1 storey)	60	13	28	20	3
2BED/3P Apartment	63	13	28	20	5
1BED/2P House (1 storey)	44	11	23	11	2
1BED/2P Apartment	45	11	23	11	3

S1 - Solution No. 1 – Proof of Concept




Categories
Rooms
Category
All Elements of Category
Category
Elements
Watch
List
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1 Room 296673
2 Room 297321
@L2 @L1 {3}
String
Name
String
Occupancy
String
Area
Element.GetParameterValueByName
element
parameterName
var[]..[]
List
0 Bedroom
1 Bedroom
2 Bedroom
@L2 @L1 {3}
Element.GetParameterValueByName
element
parameterName
var[]..[]
List
0 Main
1 Double
2 Single
@L2 @L1 {3}
Element.GetParameterValueByName
element
parameterName
var[]..[]
List
0 13.75625
1 9.76249999999999
2 5.4675
@L2 @L1 {3}
Watch
List
0 Bedroom
1 Bedroom
2 Bedroom
@L2 @L1 {3}
List.Create
item0
item1
item2
list
List
0 List
0 Bedroom
1 Bedroom
2 Bedroom
1 List
0 Main
1 Double
2 Single
2 List
0 13.75625
1 9.76249999999999
2 5.4675
@L3 @L2 @L1 {9}
List.Transpose
lists
lists
List
0 List
0 Bedroom
1 Main
2 13.75625
1 List
0 Bedroom
1 Double
2 9.76249999999999
2 List
0 Bedroom
1 Single
2 5.4675
@L3 @L2 @L1 {9}
File Path
Browse...
\Revit to Excel.xlsx
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Number
0.000
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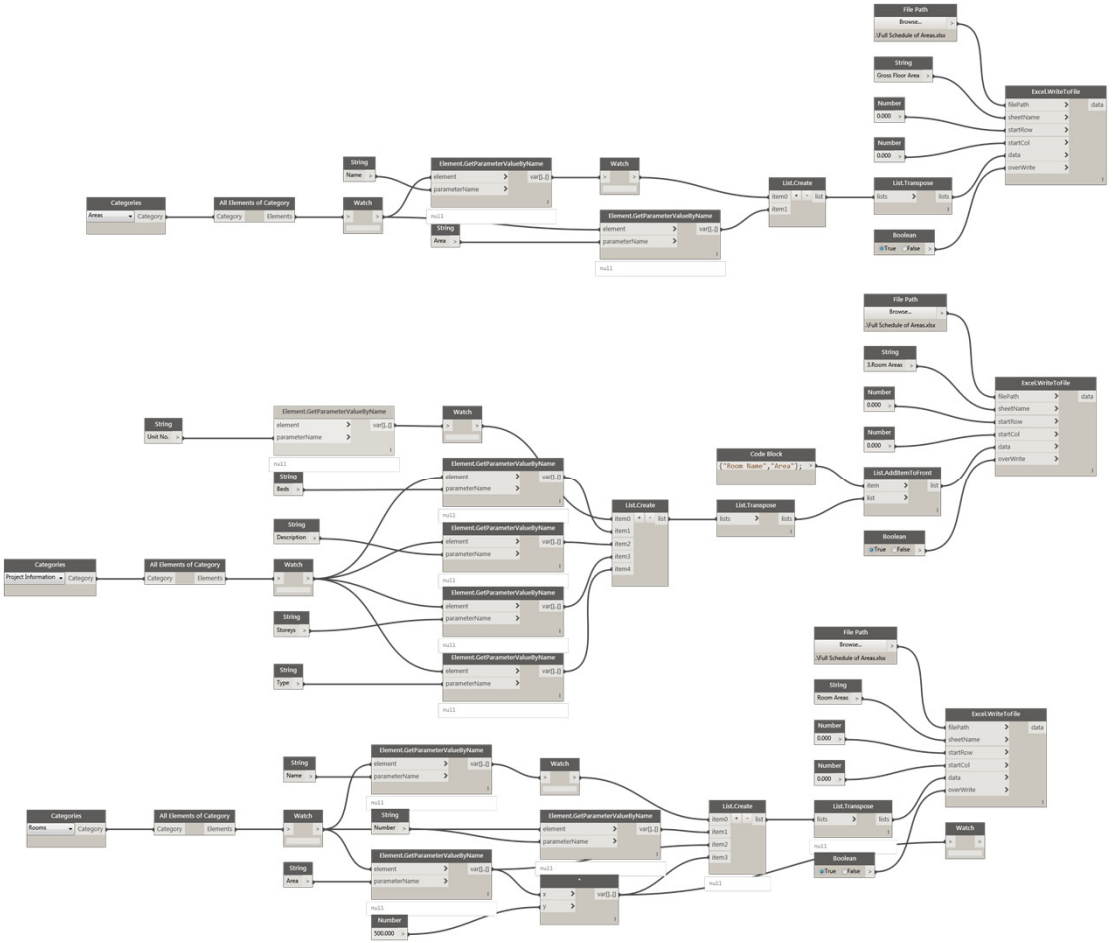
startCol
data
overWrite
data

Solution No. 2

Automated Compliance Checking: A Visual Programming Approach



Schedule of Accommodation + Residential Standards

Further Information February 2017

Reference Criteria

a) Quality Housing for Sustainable Communities 2007
b) Dublin Development Plan 2011 - 2017

Project: Residential Development at xx Site, Ireland.
Client: Not Disclosed

Unit no.	Type	Description	Storeys	Beds	Internal Ground Floor Area m² ( )	Internal First Floor Area ( ) m²	Internal Gross Floor Area ( ) m²	Requirement A Housing 2007	Requirement B Ncds Town Dir 2011 - 2017	Garden Size m²	Requirement B Ncds Town Dir 2011 - 2017	Living Room Area Req. A 4b/15m² 3b/13m² 2b/13m² Req. B N/A	Living Room Width Req. A 3b/ 3.8m 2b/ 3.6m 1b/ 3.3m Req. B N/A	Agg Living Area Req. A 4b/40m² 3b/37m² 3b/34m² 2b/30m² Req. B N/A	Bedroom Widths Req. A double 2.8m single 2.1m Req. B N/A	Agg Bedroom Area Req. A 4b/43m² 3b/36m² 3b/32m² 2b/26m² Req. B N/A	Car Parking Numbers	Storage Area m²	Requirement A Housing 2007	Requirement B Ncds Town Dir 2011 - 2017
01	D	Semidetached	2	4	77	63	140	110	110	81	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²
02	D	Semidetached	2	4	66	66	132	110	110	104	75	18	4.1	49	D 2.8 S 2.6	45.4	2	11.5m²	6m²	10 m²
03	B	Semidetached	2	3	61	51	112	100	90	102	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
04	B	Semidetached	2	3	61	51	112	100	90	99	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
05	B	Semidetached	2	3	61	51	112	100	90	99	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
06	B	Semidetached	2	3	61	51	112	100	90	96	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
07	B	Semidetached	2	3	61	51	112	100	90	93	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
08	B	Semidetached	2	3	61	51	112	100	90	93	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
09	D	Semidetached	2	4	66	66	132	110	110	99	75	18	4.1	49	D 2.8 S 2.6	45.4	2	11.5m²	6m²	10 m²
10	D	Semidetached	2	4	77	63	140	110	110	77	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²
11	B	Semidetached	2	3	61	51	112	100	90	107	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
12	B	Semidetached	2	3	61	51	112	100	90	104	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
13	B	Semidetached	2	3	61	51	112	100	90	82	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
14	B	Semidetached	2	3	61	51	112	100	90	82	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
15	B	Semidetached	2	3	61	51	112	100	90	93	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
16	B	Semidetached	2	3	61	51	112	100	90	88	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
17	A2	Terraced	2	3	53	52	105	92	90	82	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
18	A2	Terraced	2	3	53	52	105	92	90	82	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
19	A2	Terraced	2	3	53	52	105	92	90	79	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
20	A2	Terraced	2	3	53	52	105	92	90	113	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
21	D	Semidetached	2	4	77	63	140	110	110	90	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²
22	D	Semidetached	2	4	66	66	132	110	110	99	75	18	4.1	49	D 2.8 S 2.6	45.4	2	11.5m²	6m²	10 m²
23	C	Semidetached	2	4	66	66	132	110	110	94	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
24	C	Semidetached	2	4	66	66	132	110	110	94	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
25	B	Semidetached	2	3	61	51	112	100	90	82	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
26	B	Semidetached	2	3	61	51	112	100	90	82	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
27	B	Semidetached	2	3	61	51	112	100	90	92	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
28	B	Semidetached	2	3	61	51	112	100	90	91	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
29	B	Semidetached	2	3	61	51	112	100	90	88	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
30	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
31	A2	Terraced	2	3	53	52	105	92	90	75	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
32	A2	Terraced	2	3	53	52	105	92	90	69	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
33	A2	Terraced	2	3	53	52	105	92	90	83	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
34	A2	Terraced	2	3	53	52	105	92	90	93	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²

Jonathan Reinhardt

Automated Compliance Checking: A Visual Programming Approach

Schedule of Accommodation + Residential Standards

Further Information February 2017

35	B	Semidetached	2	3	61	51	112	100	90	118	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
36	B	Semidetached	2	3	61	51	112	100	90	122	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
37	B	Semidetached	2	3	61	51	112	100	90	125	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
38	B	Semidetached	2	3	61	51	112	100	90	129	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
39	D	Semidetached	2	4	66	66	132	110	110	150	75	18	4.1	49	D 2.8 S 2.6	45.4	2	11.5m²	6m²	10 m²
40	D	Semidetached	2	4	77	63	140	110	110	152	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²
41	D1	Detached	2	4	77	63	140	110	110	152	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²

42	B	Semidetached	2	3	61	51	112	100	90	104	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
43	B	Semidetached	2	3	61	51	112	100	90	105	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
44	B	Semidetached	2	3	61	51	112	100	90	110	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
45	B	Semidetached	2	3	61	51	112	100	90	110	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
46	C1	Semidetached	2	4	66	66	132	110	110	112	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
47	C1	Semidetached	2	4	67	67	134	110	110	110	75	19.3	4.1	51	D 3.04 S 2.6	46	2	11.5m²	6m²	10 m²
48	D	Semidetached	2	4	77	63	140	110	110	85	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²
49	D	Semidetached	2	4	66	66	132	110	110	93	75	18	4.1	49	D 2.8 S 2.6	45.4	2	11.5m²	6m²	10 m²
50	B	Semidetached	2	3	61	51	112	100	90	101	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
51	B	Semidetached	2	3	61	51	112	100	90	106	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
52	A3	Terraced	2	3	53	52	105	92	90	62	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
53	A3	Terraced	2	3	53	52	105	92	90	66	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
54	A3	Terraced	2	3	53	52	105	92	90	75	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
55	A3	Terraced	2	3	53	52	105	92	90	85	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
56	A2	Terraced	2	3	53	52	105	92	90	66	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
57	A2	Terraced	2	3	53	52	105	92	90	66	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
58	A2	Terraced	2	3	53	52	105	92	90	83	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
59	A2	Terraced	2	3	53	52	105	92	90	83	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
60	D	Semidetached	2	4	77	63	140	110	110	78	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²
61	D	Semidetached	2	4	66	66	132	110	110	90	75	18	4.1	49	D 2.8 S 2.6	45.4	2	11.5m²	6m²	10 m²
62	B	Semidetached	2	3	61	51	112	100	90	88	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
63	B	Semidetached	2	3	61	51	112	100	90	88	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
64	B	Semidetached	2	3	61	51	112	100	90	88	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
65	B	Semidetached	2	3	61	51	112	100	90	88	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
66	C	Semidetached	2	4	66	66	132	110	110	90	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
67	C	Semidetached	2	4	66	66	132	110	110	88	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
68	A	Terraced	2	2	44	44	88	80	75	91	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
69	A	Terraced	2	2	44	44	88	80	75	68	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
70	A	Terraced	2	2	44	44	88	80	75	62	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
71	A	Terraced	2	2	44	44	88	80	75	66	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
72	C1	Semidetached	2	4	67	67	134	110	110	91	75	19.3	4.1	51	D 3.04 S 2.6	46	2	11.5m²	6m²	10 m²
73	C1	Semidetached	2	4	66	66	132	110	110	93	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
74	B	Semidetached	2	3	61	51	112	100	90	93	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
75	B	Semidetached	2	3	61	51	112	100	90	90	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
76	B	Semidetached	2	3	61	51	112	100	90	90	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
77	B	Semidetached	2	3	61	51	112	100	90	90	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
78	B	Semidetached	2	3	61	51	112	100	90	90	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
79	B	Semidetached	2	3	61	51	112	100	90	89	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
80	D	Semidetached	2	4	77	63	140	110	110	91	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²
81	D	Semidetached	2	4	66	66	132	110	110	111	75	18	4.1	49	D 2.8 S 2.6	45.4	2	11.5m²	6m²	10 m²
82	B	Semidetached	2	3	61	51	112	100	90	91	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²

83	B	Semidetached	2	3	61	51	112	100	90	97	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
84	C1	Semidetached	2	4	66	66	132	110	110	98	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
85	C1	Semidetached	2	4	67	67	134	110	110	125	75	19.3	4.1	51	D 3.04 S 2.6	46	2	11.5m²	6m²	10 m²

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86	C	Semidetached	2	4	66	66	132	110	110	103	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
87	C	Semidetached	2	4	66	66	132	110	110	93	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
88	B	Semidetached	2	3	61	51	112	100	90	90	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
89	B	Semidetached	2	3	61	51	112	100	90	88	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
90	A	Terraced	2	2	44	44	88	80	75	51	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
91	A	Terraced	2	2	44	44	88	80	75	52	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
92	A	Terraced	2	2	44	44	88	80	75	52	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
93	A	Terraced	2	2	44	44	88	80	75	46	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
94	B	Semidetached	2	3	61	51	112	100	90	89	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
95	B	Semidetached	2	3	61	51	112	100	90	89	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
96	B	Semidetached	2	3	61	51	112	100	90	93	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
97	B	Semidetached	2	3	61	51	112	100	90	91	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
98	A2	Terraced	2	3	53	52	105	92	90	67	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
99	A2	Terraced	2	3	53	52	105	92	90	82	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
100	A2	Terraced	2	3	53	52	105	92	90	82	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
101	A2	Terraced	2	3	53	52	105	92	90	61	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
102	D	Semidetached	2	4	77	63	140	110	110	107	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²
103	D	Detached	2	4	66	66	132	110	110	109	75	18	4.1	49	D 2.8 S 2.6	45.4	2	11.5m²	6m²	10 m²
104	B	Semidetached	2	3	61	51	112	100	90	105	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
105	B	Semidetached	2	3	61	51	112	100	90	105	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
106	C	Semidetached	2	4	66	66	132	110	110	110	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
107	C	Semidetached	2	4	66	66	132	110	110	110	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
108	B	Semidetached	2	3	61	51	112	100	90	106	90	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
109	B	Semidetached	2	3	61	51	112	100	90	107	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
110	A1	Semidetached	2	3	53	52	105	92	90	66	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
111	A1	Semidetached	2	3	53	52	105	92	90	77	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
112	A1	Terraced	2	3	53	52	105	92	90	77	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
113	A1	Terraced	2	3	53	52	105	92	90	66	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
114	D	Semidetached	2	4	66	66	132	110	110	108	75	18	4.1	49	D 2.8 S 2.6	45.4	2	11.5m²	6m²	10 m²
115	D	Semidetached	2	4	77	63	140	110	110	94	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²
116	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
117	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
118	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
119	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
120	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
121	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
122	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
123	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
124	A2	Terraced	2	3	53	52	105	92	90	87	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
125	A2	Terraced	2	3	53	52	105	92	90	65	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
126	A2	Terraced	2	3	53	52	105	92	90	71	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
127	A2	Terraced	2	3	53	52	105	92	90	79	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
128	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
129	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
130	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
131	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
132	D	Semidetached	2	4	77	63	140	110	110	69	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²
133	D	Semidetached	2	4	66	66	132	110	110	87	75	18	4.1	49	D 2.8 S 2.6	45.4	2	11.5m²	6m²	10 m²
134	B	Semidetached	2	3	61	51	112	100	90	85	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
135	B	Semidetached	2	3	61	51	112	100	90	85	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
136	A2	Terraced	2	3	53	52	105	92	90	77	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²

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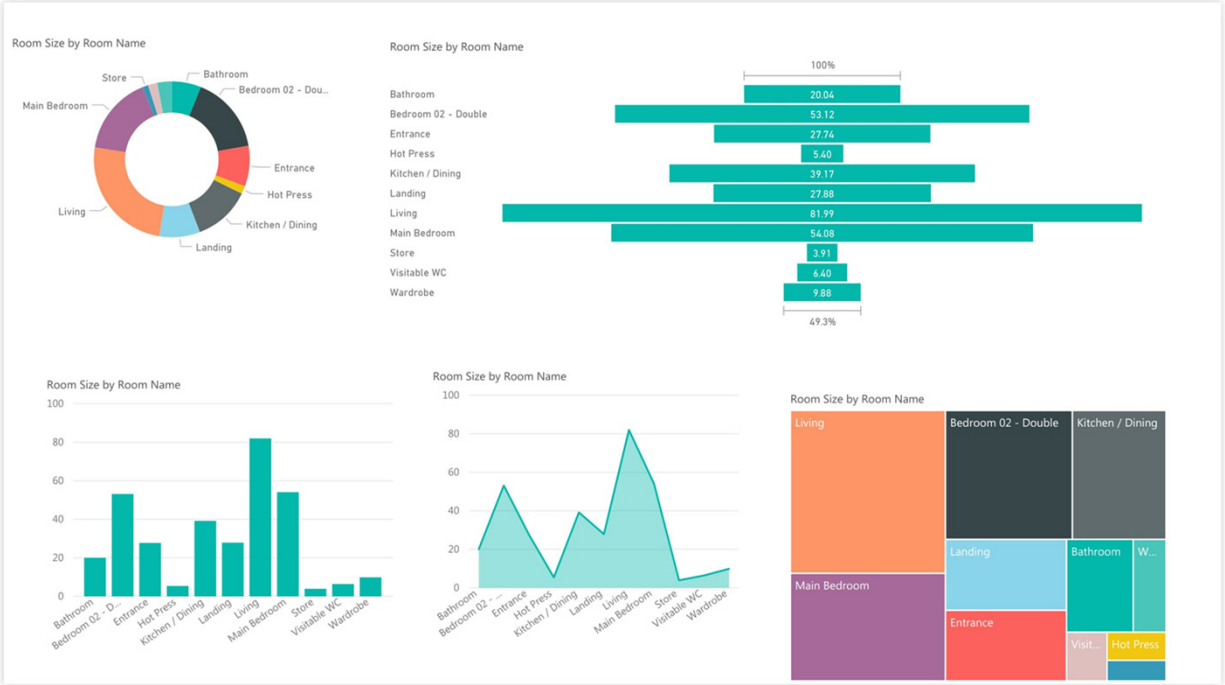
137	A2	Terraced	2	3	53	52	105	92	90	74	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
138	A2	Terraced	2	3	53	52	105	92	90	64	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
139	A2	Terraced	2	3	53	52	105	92	90	93	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
140	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
141	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
142	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
143	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
144	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
145	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
146	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
147	B	Semidetached	2	3	61	51	112	100	90	87	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
148	B	Semidetached	2	3	61	51	112	100	90	90	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
149	B	Semidetached	2	3	61	51	112	100	90	93	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
150	B	Semidetached	2	3	61	51	112	100	90	93	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
151	B	Semidetached	2	3	61	51	112	100	90	93	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
152	A	Terraced	2	2	44	44	88	80	75	60	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
153	A	Terraced	2	2	44	44	88	80	75	60	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
154	A	Terraced	2	2	44	44	88	80	75	60	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
155	A	Terraced	2	2	44	44	88	80	75	66	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
156	A1	Terraced	2	3	53	52	105	92	90	85	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
157	A1	Terraced	2	3	53	52	105	92	90	77	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
158	A1	Terraced	2	3	53	52	105	92	90	63	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
159	A1	Terraced	2	3	53	52	105	92	90	67	60	16	3.9	36	D 3.07 S 2.1	32	2	11.5m²	5m²	9 m²
160	D1	Detached	2	4	77	63	140	110	110	108	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²
161	A	Terraced	2	2	44	44	88	80	75	75	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
162	A	Terraced	2	2	44	44	88	80	75	51	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
163	A	Terraced	2	2	44	44	88	80	75	51	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
164	A	Terraced	2	2	44	44	88	80	75	74	55	20	4.4	30	D 3.0	26.7	2	6m²	4m²	6 m²
165	C	Semidetached	2	4	66	66	132	110	110	93	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
166	C	Semidetached	2	4	66	66	132	110	110	94	75	18.7	4.1	50	D 3.04 S 2.6	45	2	11.5m²	6m²	10 m²
167	B	Semidetached	2	3	61	51	112	100	90	93	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
168	B	Semidetached	2	3	61	51	112	100	90	96	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
169	B	Semidetached	2	3	61	51	112	100	90	99	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
170	B	Semidetached	2	3	61	51	112	100	90	99	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
171	B	Semidetached	2	3	61	51	112	100	90	96	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
172	B	Semidetached	2	3	61	51	112	100	90	82	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
173	D	Semidetached	2	4	66	66	132	110	110	92	75	18	4.1	49	D 2.8 S 2.6	45.4	2	11.5m²	6m²	10 m²
174	D	Semidetached	2	4	77	63	140	110	110	91	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²
175	B	Semidetached	2	3	61	51	112	100	90	112	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
176	B	Semidetached	2	3	61	51	112	100	90	125	60	16	3.8	44	D 3.1 S 2.2	34	2	11.5m²	5m²	9 m²
177	D	Semidetached	2	4	66	66	132	110	110	128	75	18	4.1	49	D 2.8 S 2.6	45.4	2	11.5m²	6m²	10 m²
178	D	Semidetached	2	4	77	63	140	110	110	117	75	21	4.1	63	D 2.8 S 2.6	41.4	2	10.5m²	6m²	10 m²

Data Visualisation



Possible Limitations – Questionnaire

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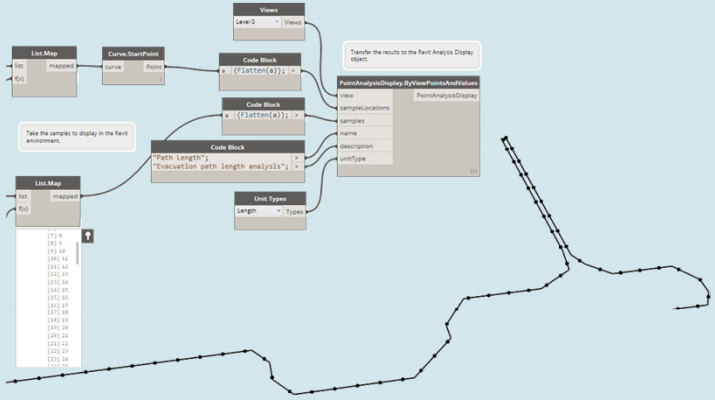
- **Do you see any drawbacks or benefits to the computer automation of design information ?**

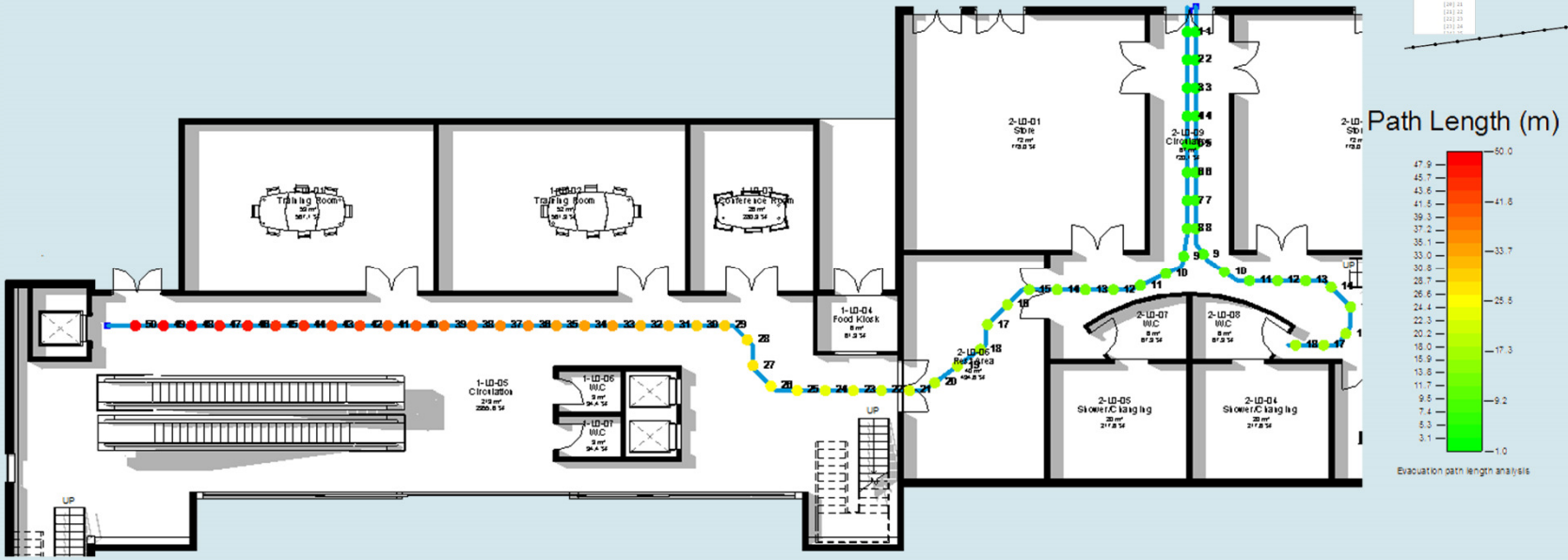
- *Benefits, particularly in the likes of storage where the lesser importance areas get a little less priority in the beginning of a project.*
- *Yes it's just leads to more inflexible rules*
- *Laziness of design?*
- *I would see a lot of benefits, in a way that it would help to keep the information clear and easier to understand.*
- *May be too rigid at design stage, but would decrease the need for redesign of areas at tender/ working stage.*
- *Extra check at design/planning stage*
- *Drawbacks - ability to interpret grey areas - over reliance meaning things may not be picked up if the automation misses something Benefits - early regulation input*

BCAR Dynamo Applications – *All following Dynamo scripts are not my work*.

Evacuation

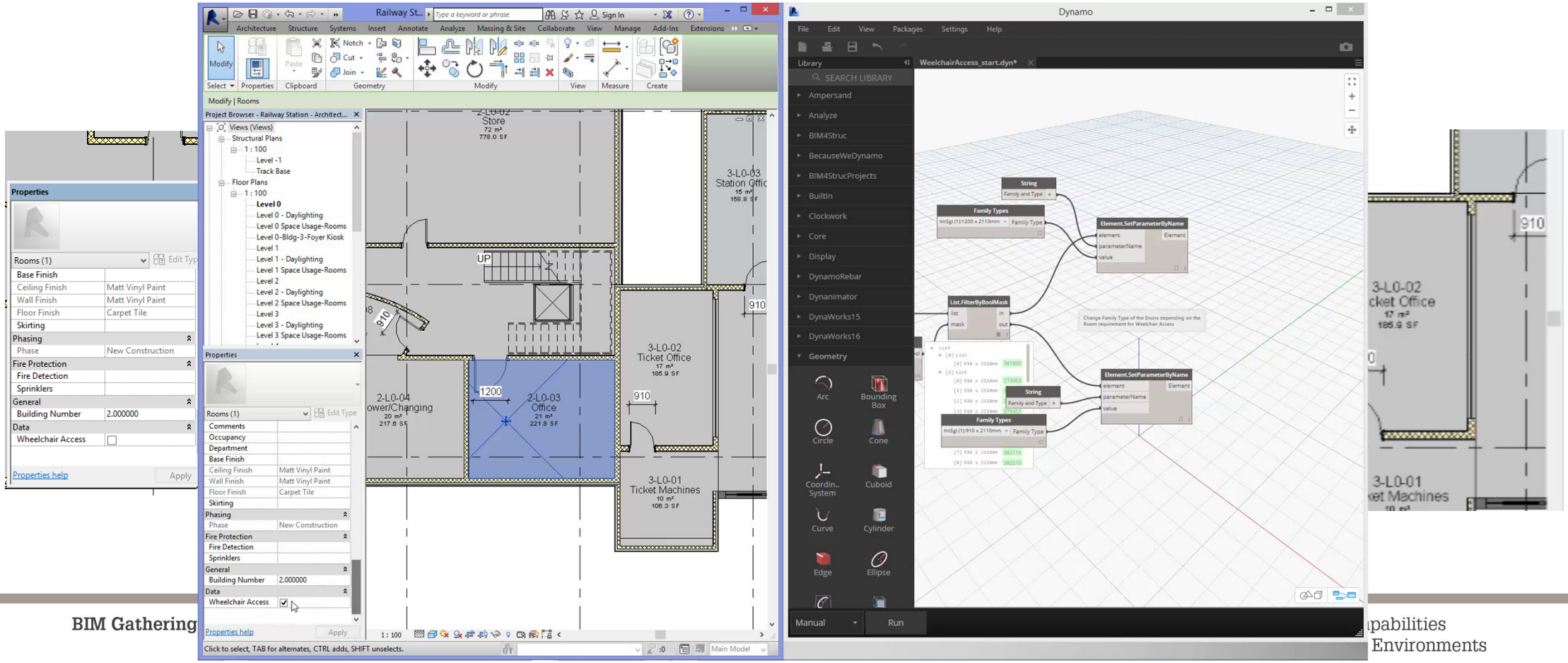
Distance from a given point and an exit.



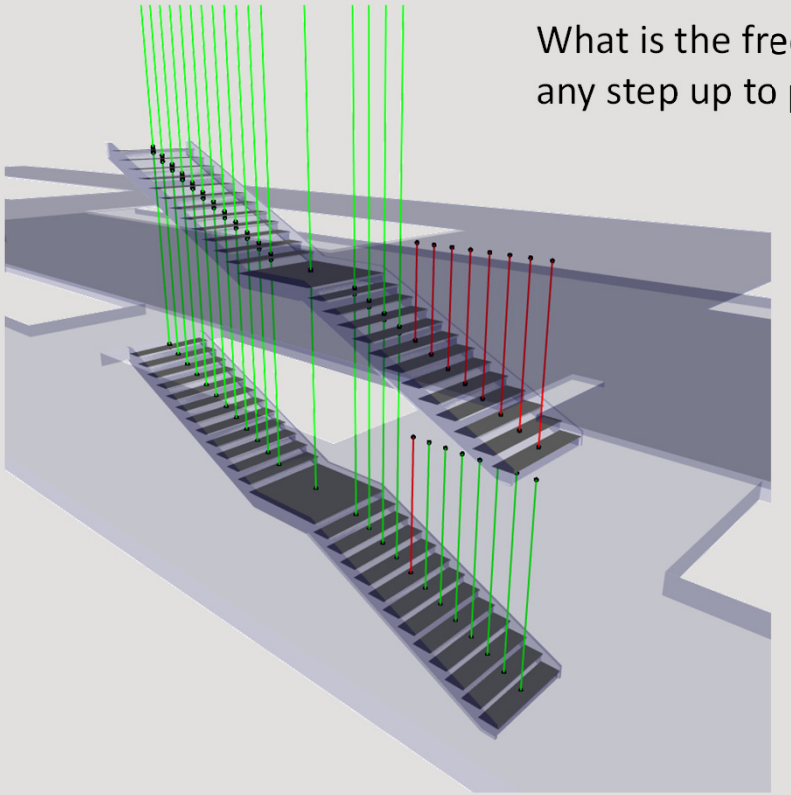


Accessible Door

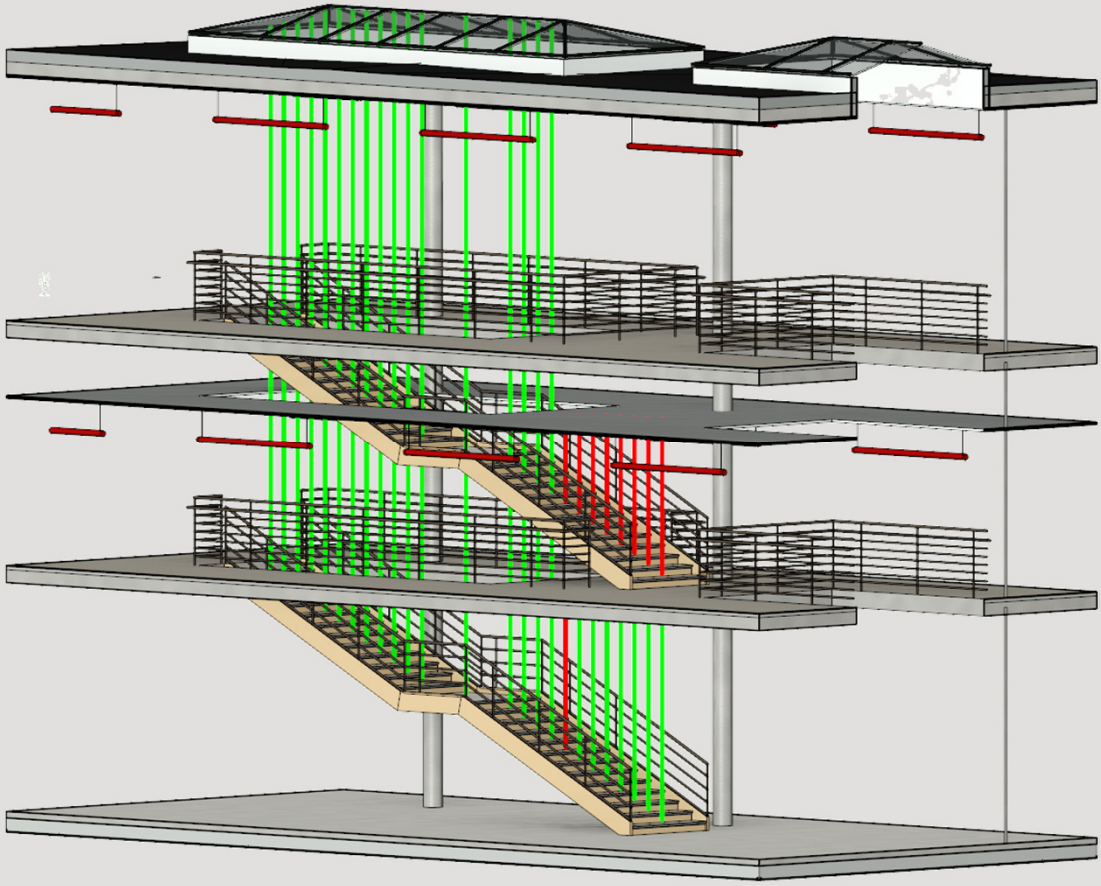
Changing the door width if space is accessible to wheelchair users. *Source Johan Cathryn Datech Solutions*



Head Height to Stairs



What is the free height from any step up to parent objects.



In Summary..

- Global Automation in Compliance Checking is growing in adoption
- Limitations and areas for further development require attention.. *Possible research project… Roadmap to Ireland adopting Automation in Local Councils – Planning & Building departments*
- Dynamo can be applied for BCAR compliance pre-checks
- Floor area compliance using Revit to Dynamo demonstrated benefits 60-70% Time Reduction

CitA
BIM GATHERING

Thank you

Jonathan Reinhardt - Datech Solutions

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