HONG KONG INSITUTE OF SURVEYORS (HKIS)
QUANTITY SURVEYING DIVISION (QSD)

Research Report

Survey & Case Study on the Quantity Surveyor's Awareness on Building Information Modeling (BIM) and its Applications in Hong Kong, Shanghai and Singapore

HKIS QSD BIM Research Team

September 2013

Introduction

As commissioned by the Hong Kong Institute of Surveyors (HKIS) Quantity Surveying Division (QSD), a research team was formed to conduct a survey of the Quantity Surveyor's Awareness of Building Information Modeling (BIM) and its Application in Hong Kong comparing with two neighboring cities i.e. Shanghai and Singapore.

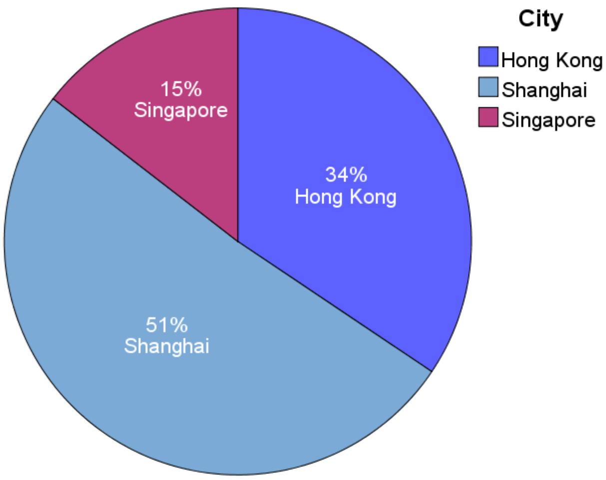
A survey was carried out during November 2012 to February 2013 with 204 no. of questionnaires received. 184 no. of respondents are practicing as Quantity Surveyors (QS) with various experience and professional qualification in different cities. Small case studies on the applications of BIM in Quantity Surveying were carrying out concurrently with the survey.

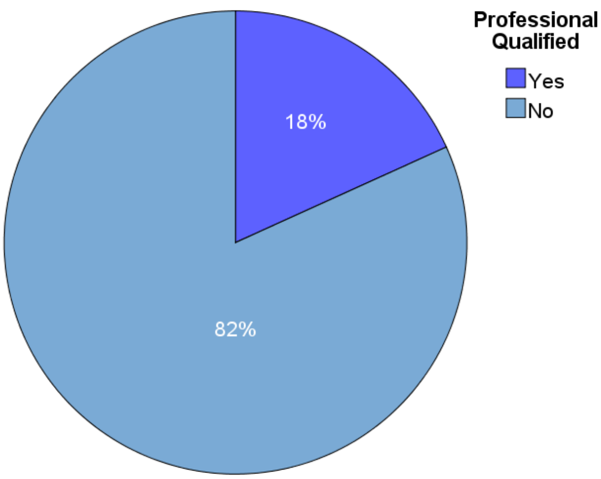
The first part of the report will focus on results of the questionnaire survey on the issues regarding QS's BIM awareness, year(s) expected to use BIM, aspects of BIM, driving forces for using BIM and aspects for which BIM can help to enhance their performance.

In the second part of the report, the research team will present some small case studies of exploring the applications of BIM in Quantity Surveying. These case studies include applications of BIM in feasibility study, cost study, preparation of bills of quantities and interim payment valuation.

To help readers have an understanding of BIM and its implementation in Hong Kong's Construction industry, the research team suggested readers to read the "BIM: Fact Sheet" issued by Construction Industry Council (CIC) on May 2013 which is available for downloading in the below website:
(http://www.hkcic.org/WorkArea/DownloadAsset.aspx?id=10628&langType=1033).

Properties of Respondents

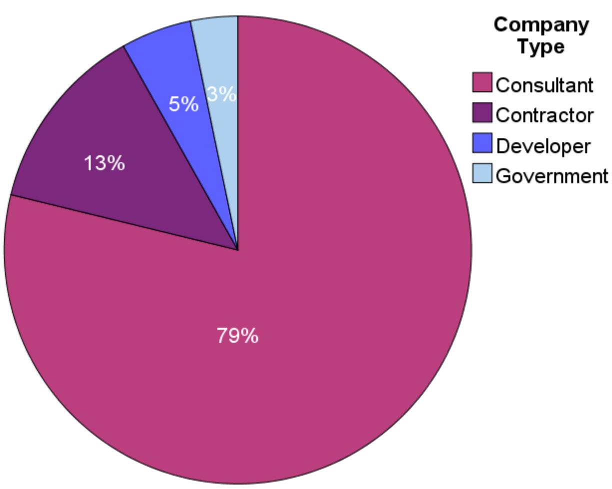


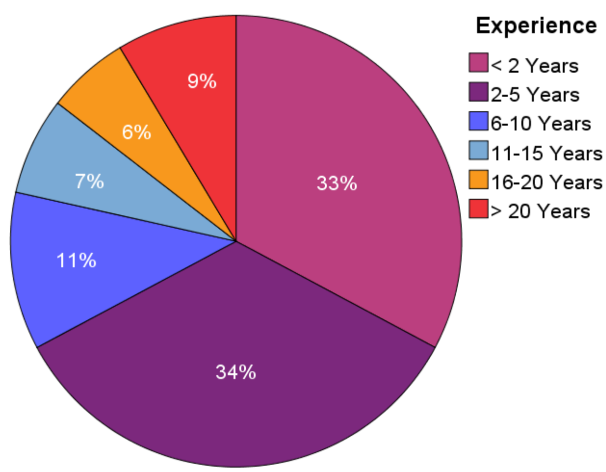


In the survey, over half of the respondents are practicing as QS in Shanghai (51%). One third of the respondents are in Hong Kong (34%) and the rest of them are in Singapore (15%).

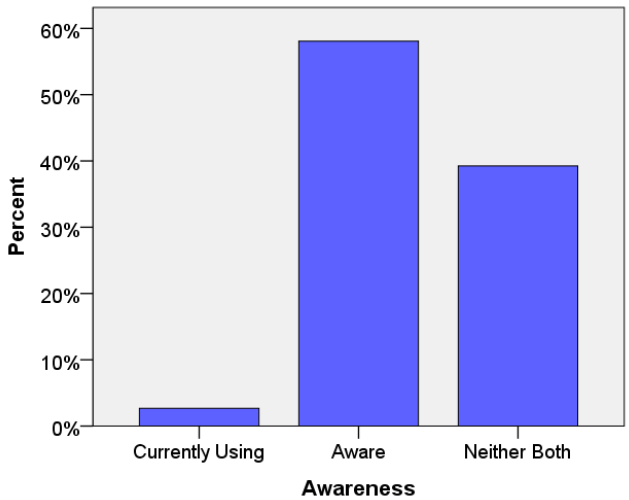
18% of the respondents are professional qualified whereas 82% are not professional qualified. These respondents are mainly working in consultant (79%) and contractor (13%). The rest of them are working in developer and government (total 8%).

About one third of the respondents have less than 2 year experience (33%) and another one third of them have 2 to 5 years of experience (34%). Almost one fourth of the respondents (24%) have 6 to 20 years of experience and another one tenth of them (9%) have over 20 years of experience.

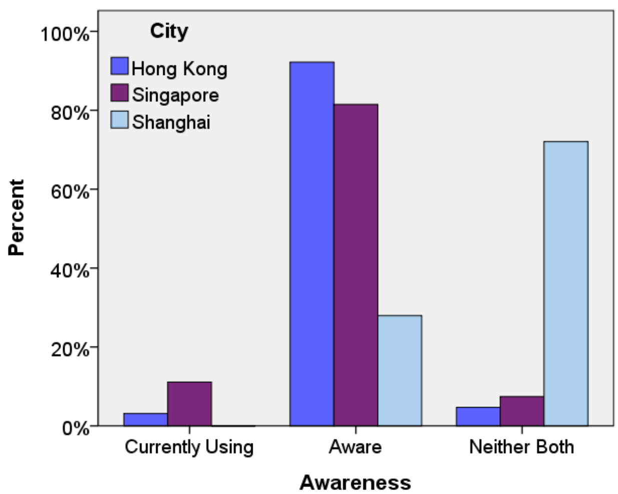




BIM Awareness



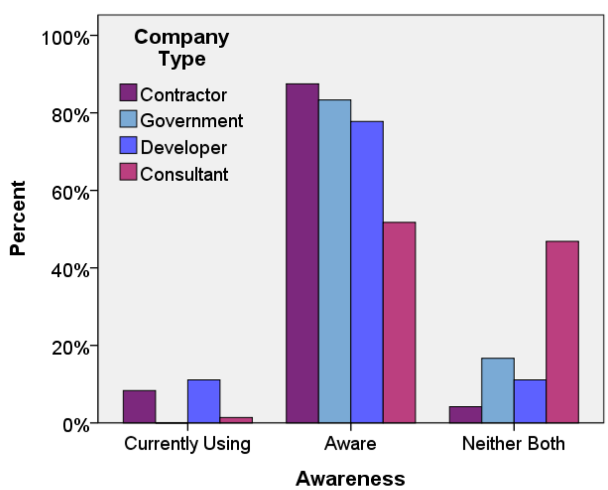
The survey results show that less than 5% of respondents are currently using BIM. Majority of the respondents (over 55%) are aware of BIM whereas around 40% of the respondents are neither currently using nor aware of BIM.

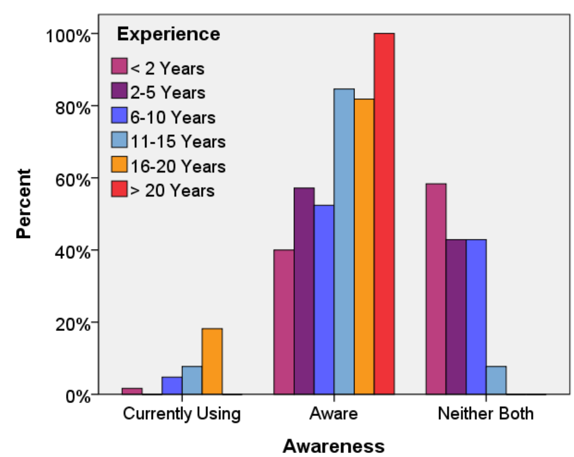


Usage of BIM in Singapore is a little bit higher than that in Hong Kong although both are less than 10%. The awareness of BIM in Hong Kong and Singapore are quite high (over 80%) comparing with the same in Shanghai (around 30%).

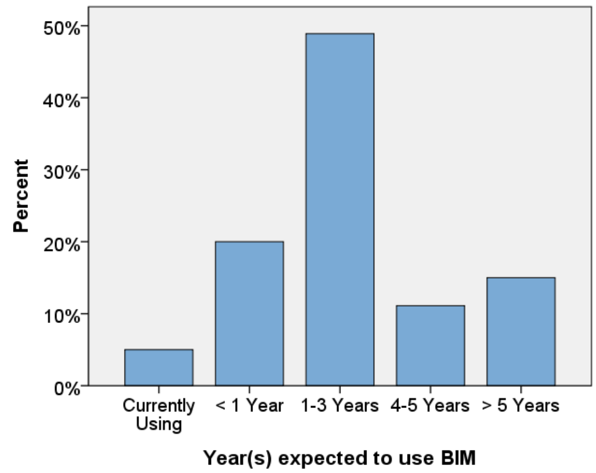
The awareness of BIM in Contractor, Government and Developer (each around 80%) is much higher than that in Consultant (around 50% only).

It seems that there is a positive linear relationship between the respondents' awareness of BIM and their working experience.



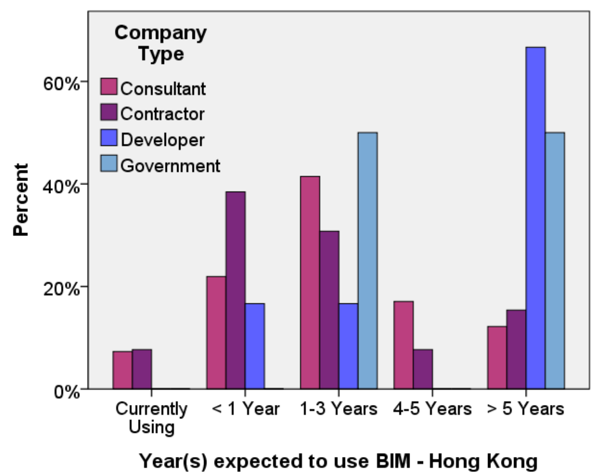


Year(s) expected to use BIM



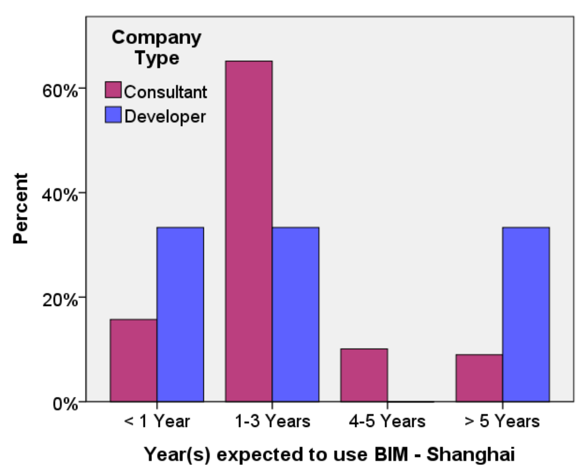
Around half of the respondents expect to use BIM within 1 to 3 years.

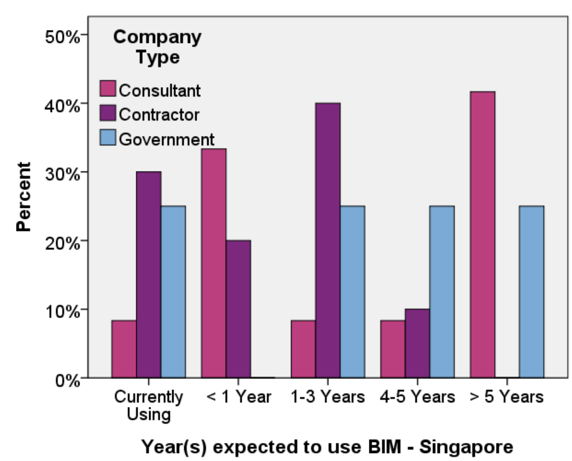
In Hong Kong, majority of respondents from Contractor and Consultant expect to use BIM within 1 to 3 years whereas the same from Developer expect to use it after 5 years. Respondents from Government have diverging views.



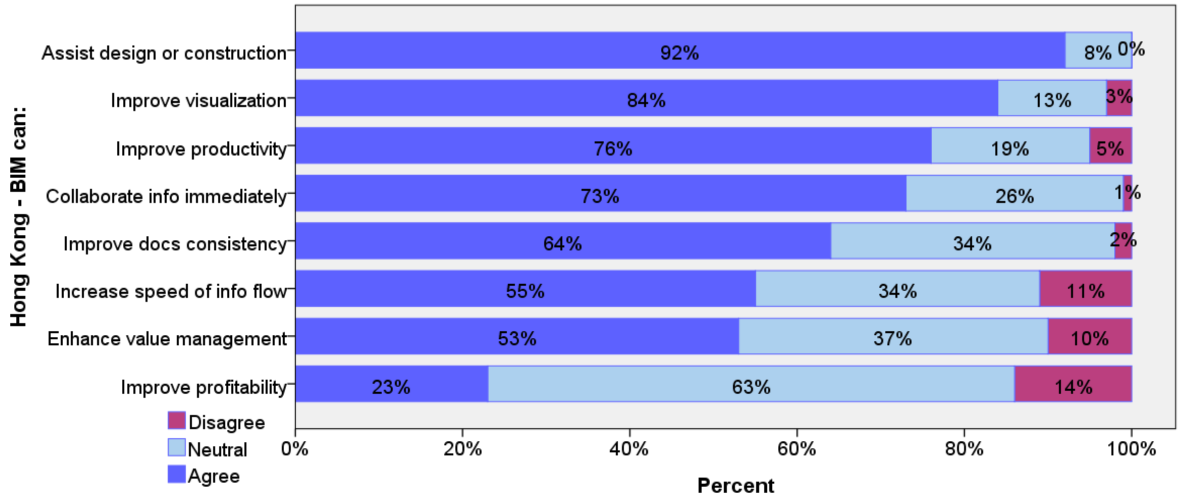
In Shanghai, majority of respondents, particularly from Consultant, expect to use BIM within 1 to 3 years. No respondents in Shanghai expect that BIM is currently using.

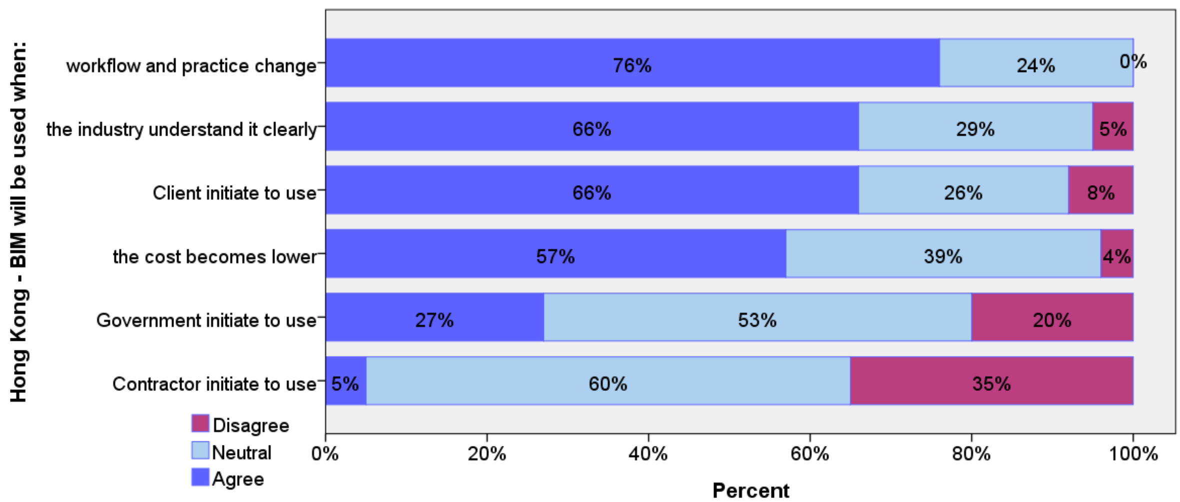
In Singapore, more respondents expect that BIM is currently using comparing to that in Hong Kong and Shanghai. Majority of respondents from Contractor expect to use BIM within 1 to 3 years whereas respondents from both Consultant and Government have diverging views.





Hong Kong



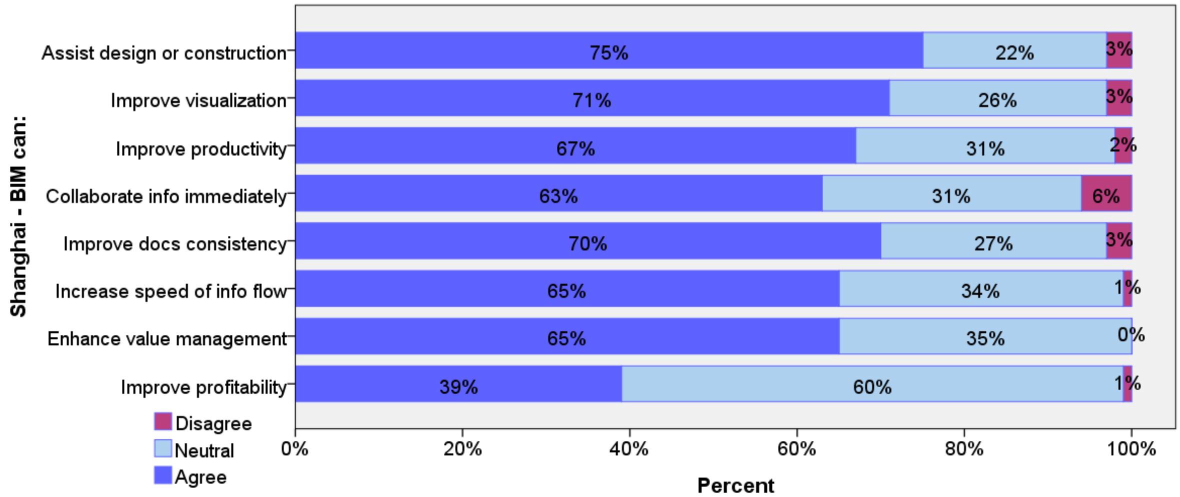


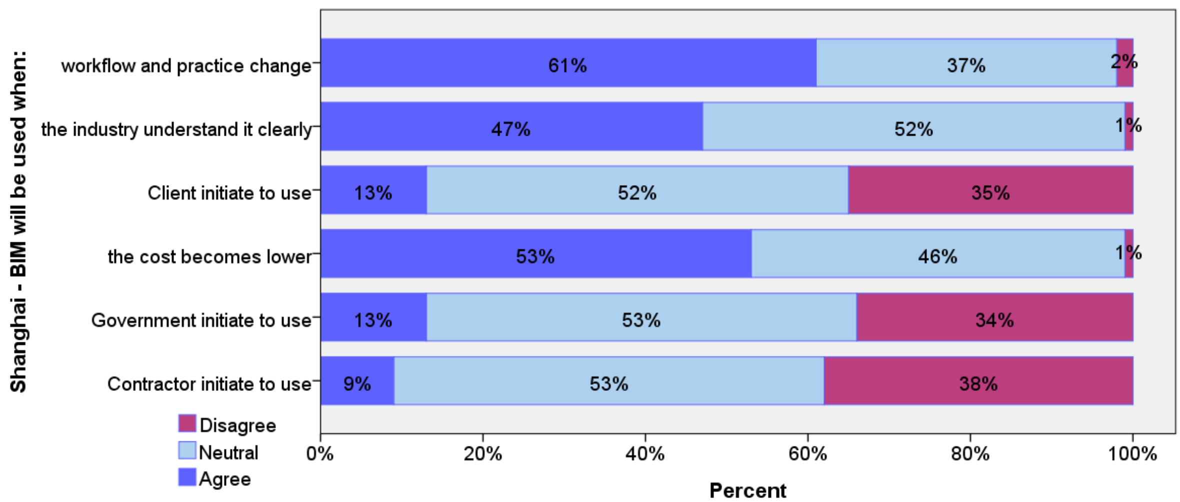
In Hong Kong, majority of respondents agree that BIM can assist design or construction; improve visualization; improve productivity; collaborate information immediately; improve documents consistency; increase speed of information flow and enhance value management. Only 23% of respondents agree that BIM can improve profitability.

Majority of respondents agree that BIM will be used when workflow and practice change (76%); when the industry understands BIM clearly (66%), when client initiate to use (66%) and the cost becomes lower (57%). These four elements seem to be the driving forces for QS to use BIM in Hong Kong.

Some respondents disagree that they will use BIM when contractor initiate to use (35%) and government initiate to use (20%).

Shanghai



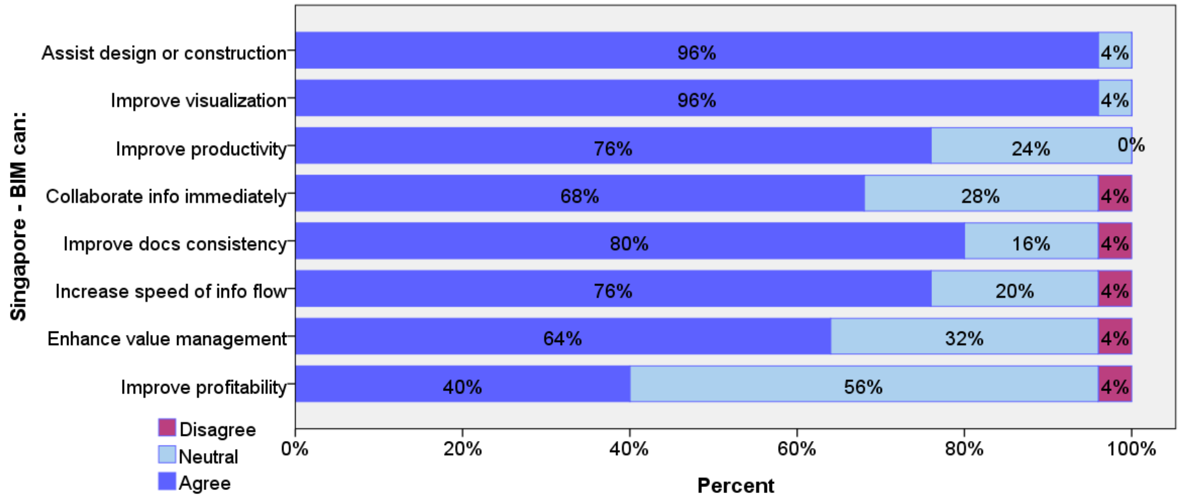


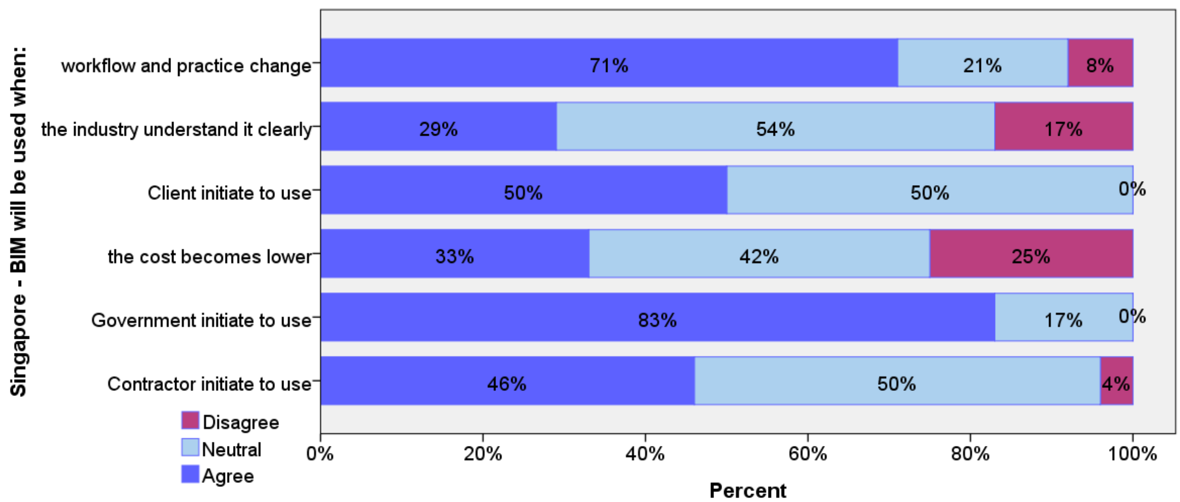
In Shanghai, majority of respondents agree that BIM is useful in various aspects. 39% of respondents agree that BIM can improve profitability.

Majority of respondents agree that BIM will be used when workflow and practice change (61%) and when the cost becomes lower (53%). Almost half of respondents (47%) agree that BIM will be used when the industry understand it clearly. Only 13% of respondents agree that they will use BIM when either government or client initiate to use.

Some respondents disagree that they will use BIM when contractor initiate to use (38%); client initiate to use (35%) and government initiate (34%) to use.

Singapore



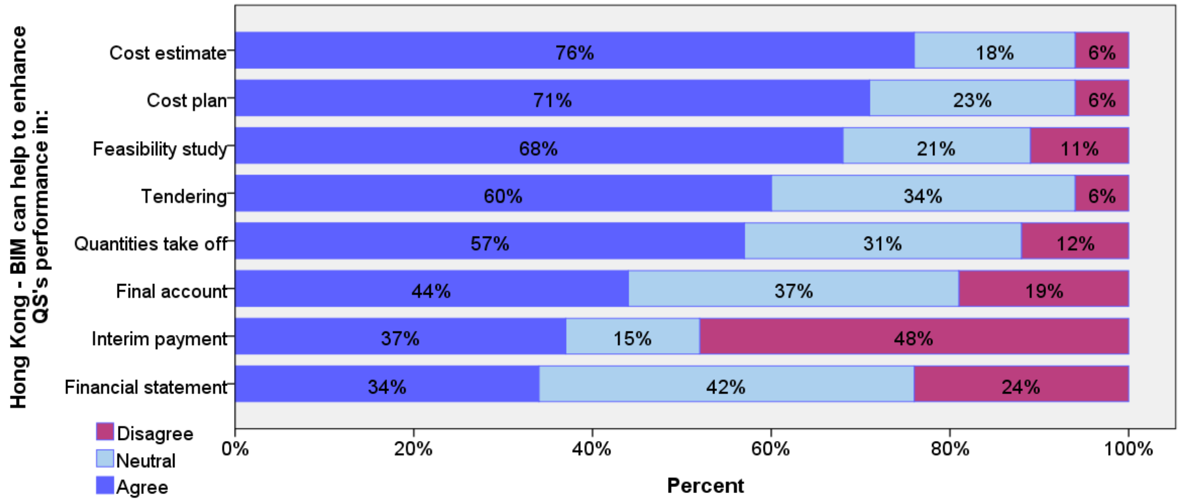


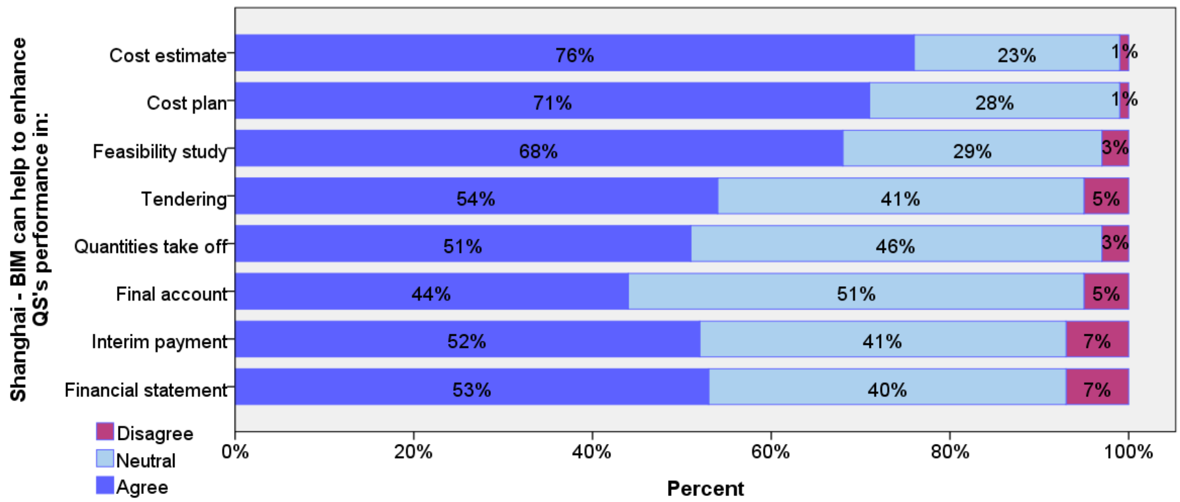
In Singapore, higher percentages of respondents agree that BIM is useful in various aspects when comparing to Hong Kong and Shanghai. Particularly, more respondents in Singapore (40%) agree that BIM can improve profitability.

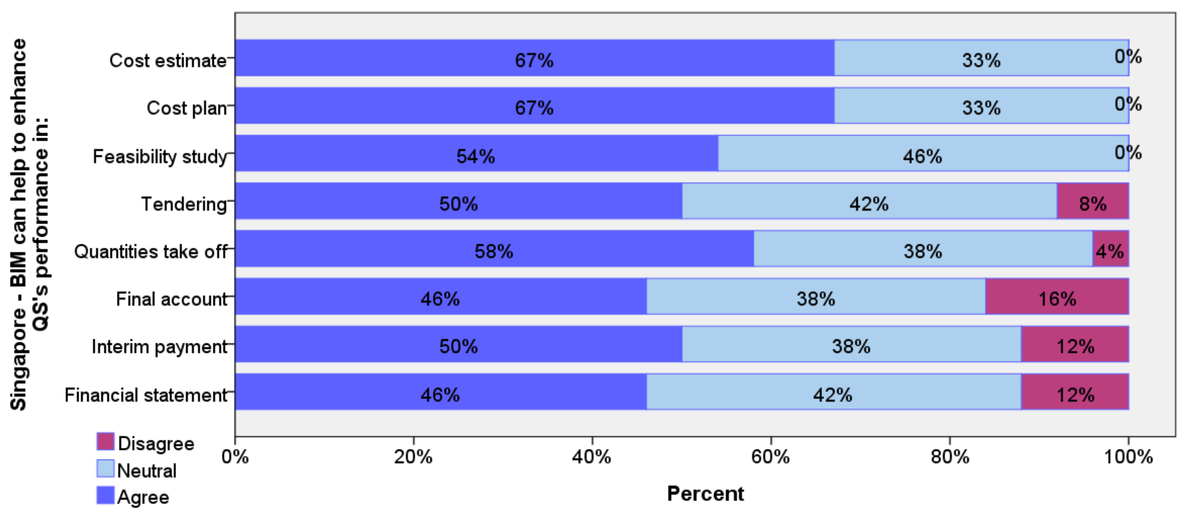
Majority of respondents agree that BIM will be used when government initiate to use (83%) and workflow and practice change (71%). Around half of respondents agree that BIM will be used when either client initiate to use (50%) or contractor initiate to use (46%).

Some respondents in Singapore disagree that they will use BIM when the cost becomes lower (25%) and when the industry understand it clearly (17%).

BIM help to enhance QS's performance







BIM help to enhance QS's performance

Majority of respondents in Hong Kong, Shanghai and Singapore agree that BIM can help to enhance their performance in pre-contract tasks including feasibility study, cost estimate, cost plan, quantities take off and tendering. Around half of respondents agree that BIM can help to enhance their performance in post contract tasks including interim payment, financial statement and final account.

Particularly in Hong Kong, around half of respondents (48%) disagree that BIM can help to enhance their performance in interim payment. Some of the respondents also disagree the same in financial statement (24%) and final account (19%).

Conclusion

The survey results show that in Hong Kong, Shanghai and Singapore, very few QS are currently using BIM but most of them are aware of it. This awareness seem to be positively related to their years of working experience and thus explaining that the awareness of consultant QS is relatively low because more young surveyors are employed by their company.

Most of the QS in all three cities expect to use BIM in 1 to 3 years, particular for those from consultant. However, some developer's and government's QS in Hong Kong hold a conservative view that BIM will be used after 5 years.

In all three cities, most of the QS agree that BIM is useful in various aspects except for improving profitability. In Hong Kong and Shanghai, similar driving forces for QS to use BIM are identified as: change in workflow and practice, understanding of BIM and client initiation. Whereas in Singapore, government initiation and change in workflow and practice are the two dominant driving forces.

Most QS in all three cities agree that BIM can help to enhance their performance, particularly in pre-contract tasks including feasibility study, cost estimate, cost plan, quantities take off and tendering.

Feasibility Study

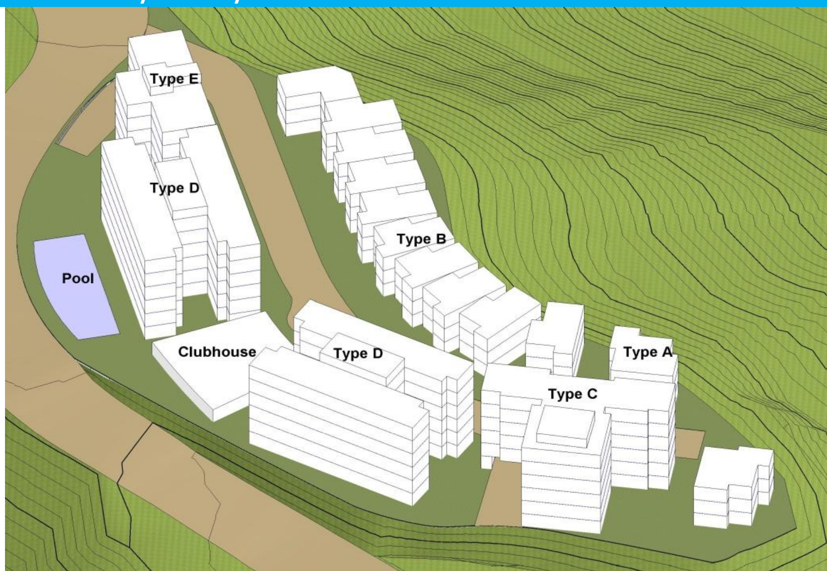
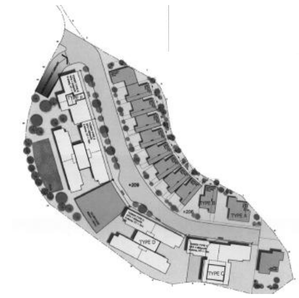


Figure 1 -
Design Scheme 1



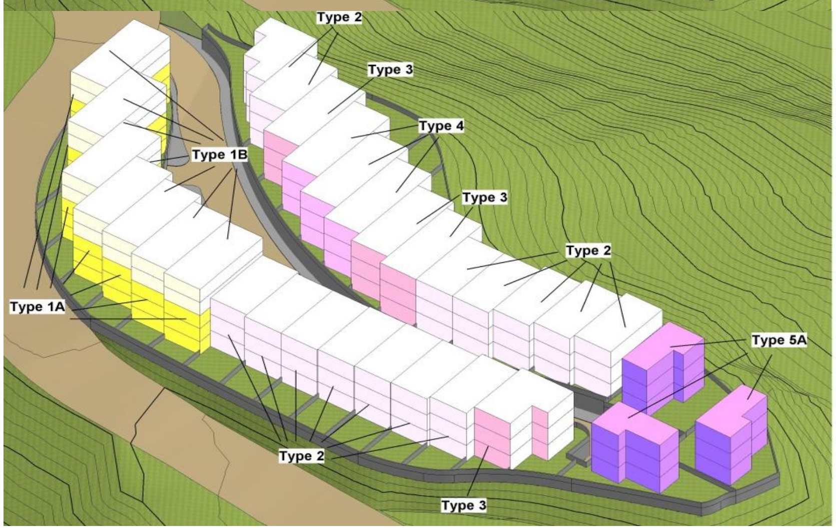


Figure 2 -
Design Scheme 2

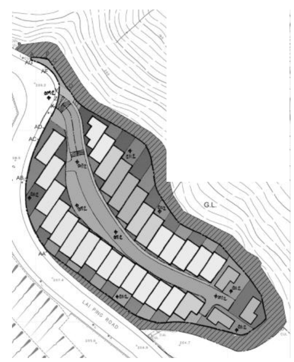


Figure 1 and Figure 2 above show two design schemes and their corresponding BIM models for a residential development at project feasibility stage. An in-house QS in a property developer was assigned to prepare preliminary cost estimates for these two schemes. The BIM research team proposed to build a massing model by BIM so that key information including construction floor areas (CFA) and external wall areas can be extracted from the model easily.

Both the QS and property developer appreciated the use of BIM for the situation which helped to produce easily the required information of different schemes for cost estimating and also helped to enhance visualization for schemes comparison.

Cost Study

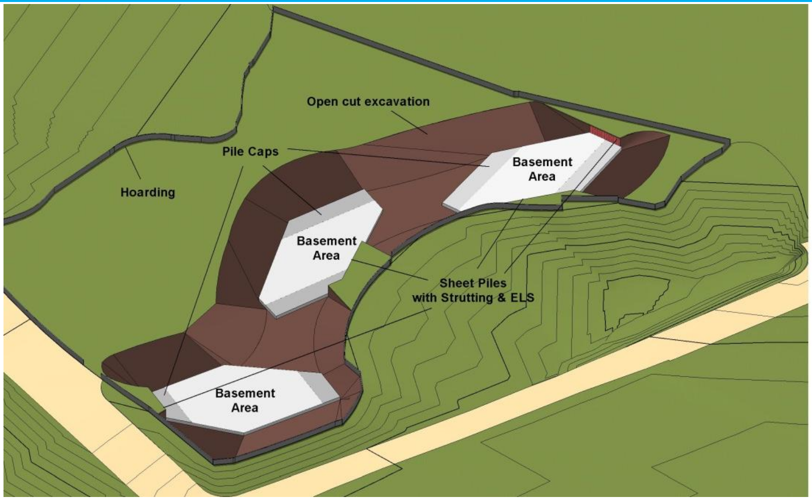


Figure 3 - Basement Design for Scheme 1

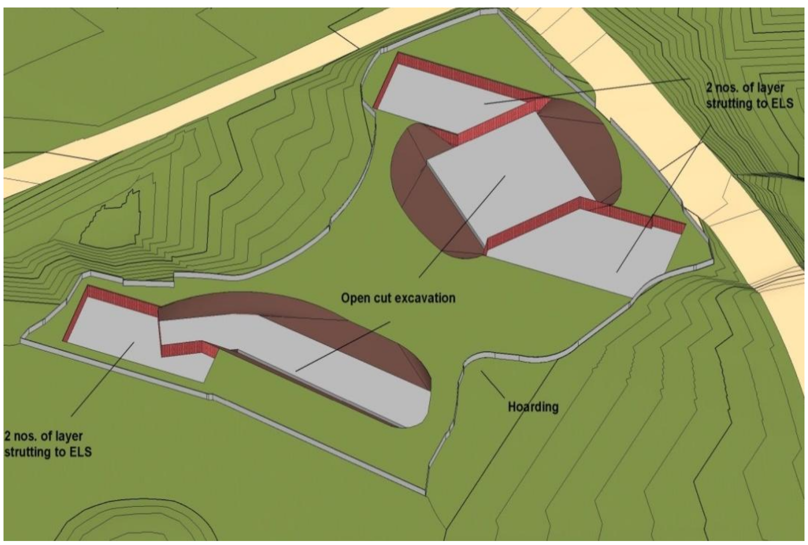


Figure 4 - Basement Design for Scheme 2

Figure 3 and Figure 4 above show two basement design schemes and their corresponding BIM models for a residential development at project feasibility stage. An in-house QS in a property developer was assigned to prepare preliminary cost estimate and comparison for two basement design schemes. The BIM research team proposed to build a model by BIM so that key information including volume of soil excavation, backfilling and removal, areas of sheet piling and lateral support can be extracted from the model easily.

Both the QS and property developer appreciated the use of BIM for the situation which helped to produce easily the required information of different basement schemes for cost estimating and comparing and also helped to enhance visualization for schemes comparison.

Cost Study

Development 1					Development 2					Development 3				
CFA:	246.43				CFA:	670.89				CFA:	561.77			
Elements	Area / No. (A)	Unit	CFA (m2) (B)	Ratio (A)/(B)	Elements	Area / No. (A)	Unit	CFA (m2) (B)	Ratio (A)/(B)	Elements	Area / No. (A)	Unit	CFA (m2) (B)	Ratio (A)/(B)
External Wall	241.33	m2	246.43	0.979304	External Wall	614.62	m2	670.89	0.9161263	External Wall	614.62	m2	561.77	1.094078
Internal Wall	342.62	m2	246.43	1.390334	Internal Wall	771.03	m2	670.89	1.1492644	Internal Wall	771.03	m2	561.77	1.372501
Total Wall	583.95	m2	246.43	2.369638	Total Wall	1385.65	m2	670.89	2.0653907	Total Wall	1385.65	m2	561.77	2.466579
Lift	10.5	m2	246.43	0.042608	Lift	11.03	m2	670.89	0.0164408	Lift	11.05	m2	561.77	0.01967
Staircase	18.84	m2	246.43	0.076452	Staircase	14.48	m2	670.89	0.0215833	Staircase	18.45	m2	561.77	0.032843
Corrdor Area	23.62	m2	246.43	0.095849	Corrdor Area	26.88	m2	670.89	0.0400662	Corrdor Area	42.36	m2	561.77	0.075405
E&M room	7.79	m2	246.43	0.031611	E&M room	20.18	m2	670.89	0.0300794	E&M room	15.09	m2	561.77	0.026862
Fire Lobby	10.89	m2	246.43	0.044191	Fire Lobby	19.33	m2	670.89	0.0288125	Fire Lobby	22.17	m2	561.77	0.039465
Core Area	71.64	m2	246.43	0.290711	Core Area	91.9	m2	670.89	0.1369822	Core Area	109.12	m2	561.77	0.194243
Door	29	No.	246.43	0.11768	Door	50	No.	670.89	0.0745279	Door	61	No.	561.77	0.108585

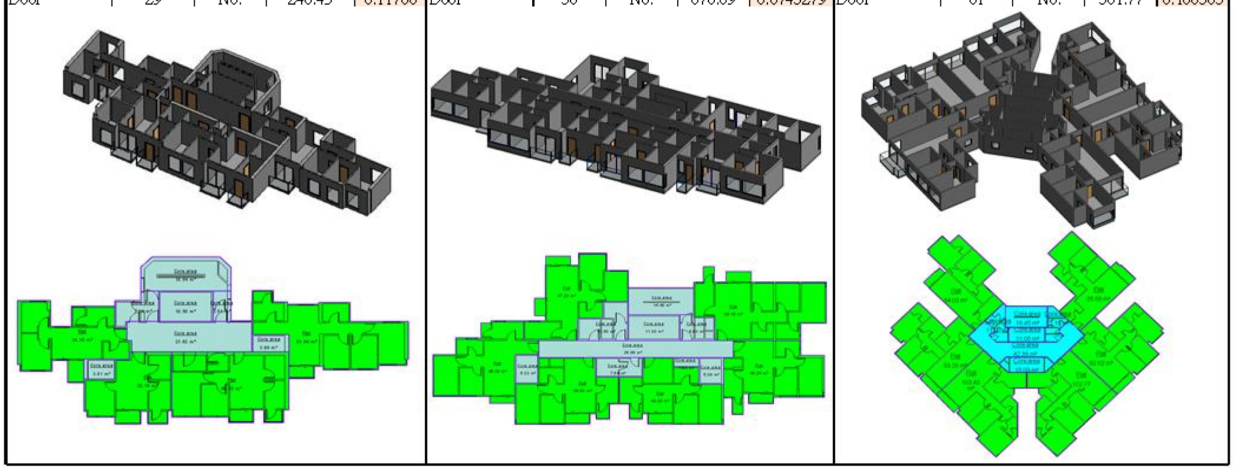
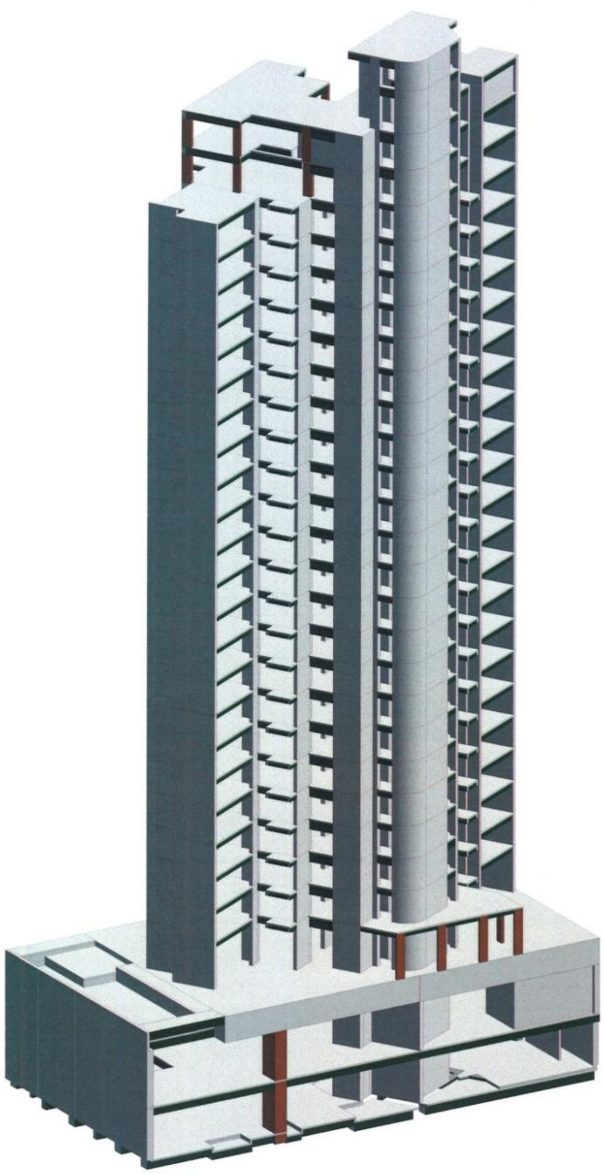


Figure 5 – Comparison of Elemental Ratios for Design Efficiency Study

Figure 5 above shows a comparison of elemental ratios for design efficiency study. An in-house QS in a property developer was assigned to carry out a design efficiency study of different layout of multi-storey residential buildings. The BIM research team proposed to build BIM models so that key information including construction floor areas, internal and external wall areas for calculating "wall to floor ratio", core and services areas for calculating "core to floor ratio" can be extracted from the models easily as indicators of design efficiency.

Both the QS and property developer appreciated the use of BIM for the situation which provided quantitative information easily for comparing the design efficiency of different layouts.

Bills of Quantities



	Concrete	Formwork
BIM	3,588.94	23932.56
Manual	3,549.04	23,954.17
Difference	39.90	(21.61)
% of Difference	1.12%	-0.09%

Slab (m3)		
Floor	Concrete	Formwork
UR/F	7.69	55.68
R/F	16.82	127.49
30/F	16.34	122.51
29/F	26.06	167.14
28/F	28.45	176.96
27/F	28.45	176.96
11/F - 26/F (exclud 13/F,14/F & 24/F)	369.85	2,300.48
5/F - 10/F	170.70	1,061.76
3/F	31.81	200.33
2/F	10.45	65.90
Transfer plate	1,236.80	716.48
1/F	47.82	368.28
G/F	57.10	417.27
	2,048.34	5,957.24

Beam (m3)		
Floor	Concrete	Formwork
UR/F	6.70	67.11
R/F	20.39	183.65
30/F	21.09	186.40
29/F	22.73	204.97
28/F	18.80	187.51
27/F	18.80	187.51
11/F - 26/F (exclud 13/F,14/F & 24/F)	244.40	2,437.63
5/F - 10/F	112.80	1,125.06
3/F	22.25	221.38
2/F	18.00	107.65
Transfer plate	0.00	0.00
1/F	192.55	673.47
G/F	133.51	578.65
	832.02	6,160.99

Structure Wall (m3)		
Floor	Concrete	Formwork
UR/F	12.00	75.42
R/F	25.72	191.56
30/F	42.50	296.87
29/F	44.41	309.04
28/F	56.80	402.40
27/F	56.80	402.40
11/F - 26/F (exclud 13/F,14/F & 24/F)	738.40	5,231.20
5/F - 10/F	340.80	2,414.40
3/F	56.63	402.80
2/F	91.08	684.78
Transfer plate	5.51	59.98
1/F	149.65	706.34
G/F	147.28	661.58
	1,767.57	11,838.77

Column (m3)		
Floor	Concrete	Formwork
UR/F	NA	NA
R/F	NA	NA
30/F	3.17	35.02
29/F	3.17	35.02
28/F	NA	NA
27/F	NA	NA
11/F - 26/F (exclud 13/F,14/F & 24/F)	NA	NA
5/F - 10/F	NA	NA
3/F	NA	NA
2/F	2.70	36.00
Transfer plate	28.80	100.00
1/F	82.37	286.00
G/F	57.60	200.00
	177.81	692.04

Figure 6 – BIM Structural Model for a Residential Building

Bills of Quantities

Superstructure		
	Concrete (m3)	Formwork (m2)
Slab	1,327.98	6,032.67
Beam	1,368.94	7,210.40
Structure wall	2064.93	10132.82
Column	711.13	2838.61
	5472.98	26214.50

Comparison of Measurement (Superstructure)		
	Concrete (m3)	Formwork (m2)
BIM	5472.98	26214.5
Manual	5685.00	27842.00
Difference	(212.02)	(1,627.50)
% of Difference	-3.73%	-5.85%

Figure 7 – BIM Structural Model for a Office Building

Figure 6 and 7 show BIM structural models for a residential and office building respectively.

A consultant QS had measured the quantities of structural frame including concrete and formwork for slab, beam, structural and column by manual measurement from drawings for the above two projects. The research team proposed to build up BIM models for quantities checking and feasibility of BIM quantities taking off with reference to the suggestions on model building protocols made from the results of the joint-research by HKIS QSD and HKIBIM.

The results showed that there are around ±1% and ±5% differences between manual and BIM measurement for the two cases respectively.

Interim Payment

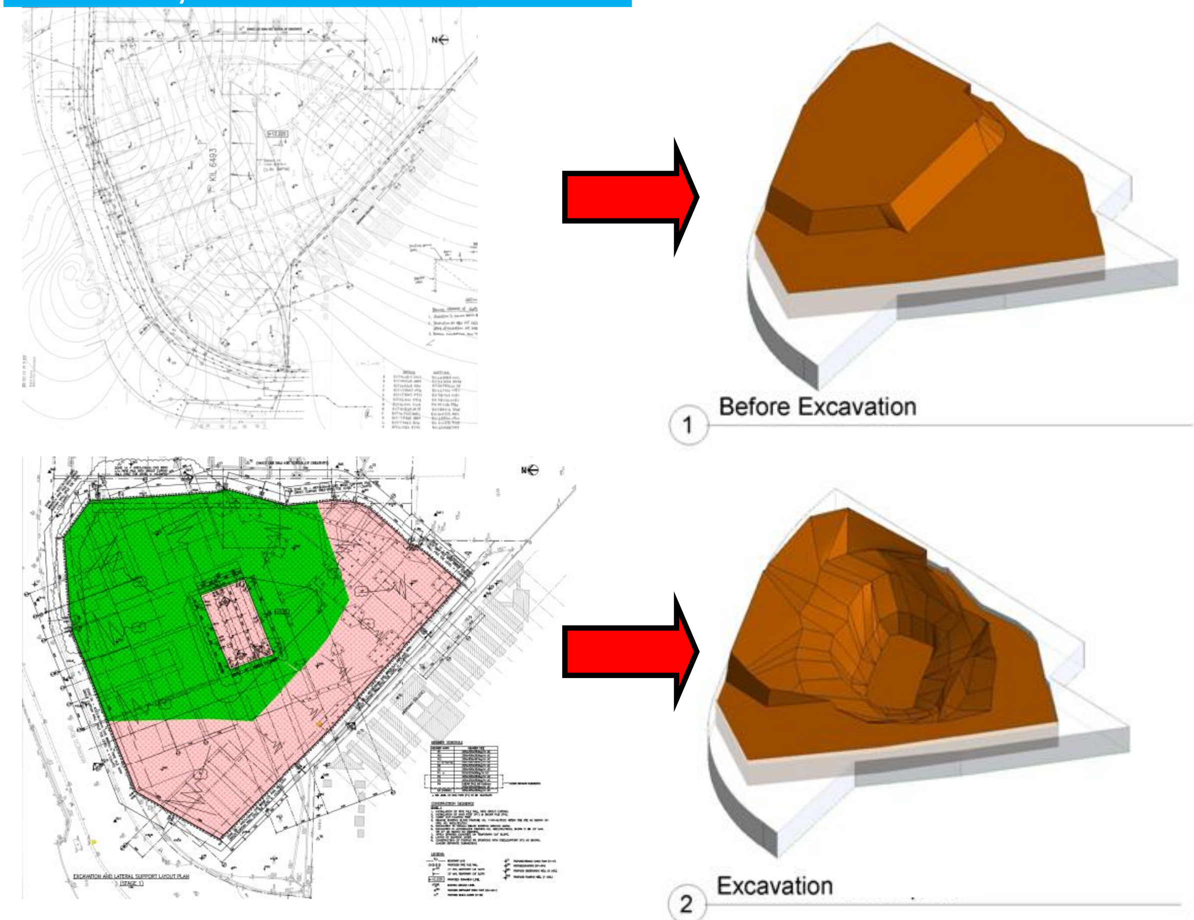


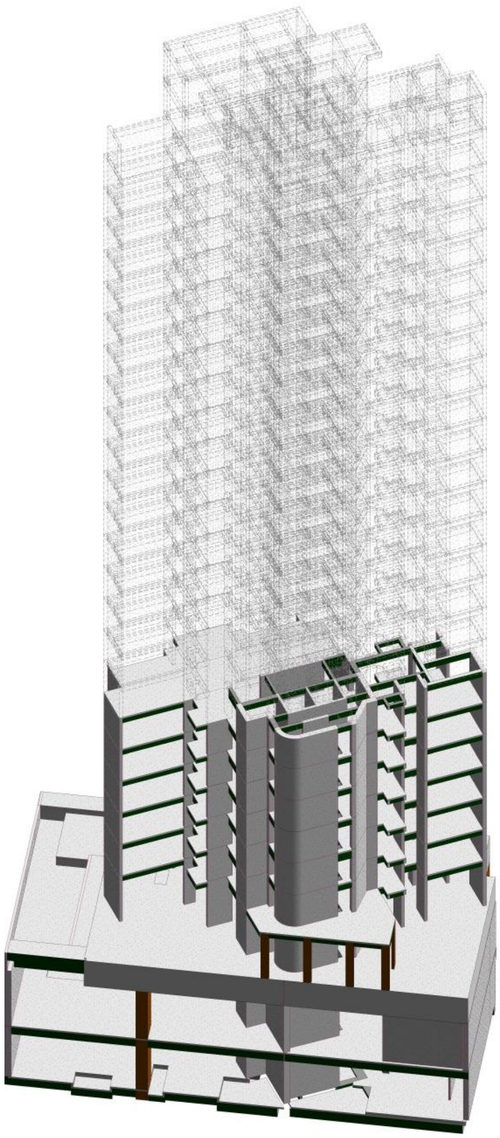
Figure 8 – Measurement of Soil Excavation in Interim Payment

Figure 8 shows a BIM model for soil excavation of a residential project during post contract stage.

The foundation contractor raised a dispute with the consultant QS on the volume of soil excavation for basement and pile cap works during interim payment valuation. The research team proposed to build BIM models to calculate the volume of excavation by transformation of 2D drawings and survey points to simulate the site before excavation and after excavation as at the date of valuation.

The dispute was settled by comparing the difference in soil volume between the two models.

Interim Payment



Slab (m3)		
Floor	Concrete	Formwork
5/F - 10/F	170.70	1,061.76
3/F	31.81	200.33
2/F	10.45	65.90
Transfer plate	1,236.80	716.48
1/F	47.82	368.28
G/F	57.10	417.27
	1,554.68	2,830.02

Beam (m3)		
Floor	Concrete	Formwork
5/F - 10/F	112.80	1,125.06
3/F	22.25	221.38
2/F	18.00	107.65
Transfer plate	0.00	0.00
1/F	192.55	673.47
G/F	133.51	578.65
	479.11	2,706.21

Structure Wall (m3)		
Floor	Concrete	Formwork
5/F - 10/F	340.80	2,414.40
3/F	56.63	402.80
2/F	91.08	684.78
Transfer plate	5.51	59.98
1/F	149.65	706.34
G/F	147.28	661.58
	790.94	4,929.88

Column (m3)		
Floor	Concrete	Formwork
2/F	2.70	36.00
Transfer plate	28.80	100.00
1/F	82.37	286.00
G/F	57.60	200.00
	171.47	622.00

Figure 9 – Measurement of Work Done in Interim Payment

Figure 9 shows a model built from the previously mentioned case of a residential building with the contractor's work done up to and including the 5th floor slab. To carry out feasibility study on using BIM in interim payment valuation, the BIM research team modified the model built from the previously mentioned case of a residential building by highlighting the contractor's work done in the model as at the date of valuation.

It is found that contractor's works done such as the quantities of concrete casted and formwork erected could be easily generated from the model in both the model and the quantities table.