DProf thesis

Change management for adoption of building information modelling (BIM) in the construction industry

Low, H.

Change Management for Adoption of Building Information Modelling (BIM) in the Construction Industry

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LOW, Hon Wah

Institute for Work Based Learning

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Abbreviations

Acronym	Full Form
AEC	Architecture, engineering and construction
BIM	Building Information Modelling
BIM	For this paper, "BIM" refers to "Building Information Modelling" when it is used as a noun. When used as an adjective, "BIM" is no longer an acronym but serves to act as the attribute of the noun following it. For example, "BIM Model" refers to a "Model" used in BIM, and "BIM Technology" refers to the technology being used in BIM.
HKCIC	The Construction Industry Council of Hong Kong
HKSAR	The Hong Kong Special Administrative Region, China
PolyU	The Hong Kong Polytechnic University

Glossary

Glossary of terms used in this paper are listed below in four main categories:

Analysis Related Terms

Building Information Modelling (BIM) Related Terms

Change Factor and Analysis Related Terms

Change Management Framework (CMF) Related Terms

Analysis Related Terms

Analysis Related Terms	Description
Adoption Level for the "Change Adoption Status" Category	The levels assigned to the groups in the Change Adoption Status Category. They follow the sequence of the status in a Change Adoption Curve as follows: Level 1: Awareness (the lowest level) Level 2: Understanding Level 3: Acceptance Level 4: Readiness Level 5: Sustainment (the highest level)
Affordability	Literally, this explains how much the person or organisation could afford to implement the change, i.e., the "affordability to change". In this paper, this term is further used in the description of how much a person or organisation could afford "not to change", i.e., the "affordability not to change".
Attitude Level for the "General Attitude" Category	These refer to the levels of driving force imposed in change implementations: Level 1: Conservative Level 2: Anxious Level 3: Determined Level 4: Enthusiastic
Change Adoption Status	For this paper, the term "change adoption status" refer to the people's status, mainly in terms of their knowledge in changes for BIM implementation.

Analysis Related Terms	Description
Change Adoption Status - categories	The categorising approach follows the status categories laid out in the "change adoption curve" developed by a network of experienced change management professionals (Change Management Solutions Canada, 2021). The following five categories are used in this paper for describing people's status in adopting changes for BIM implementation: **Awareness**: people under this category have the knowledge in the changes to be adopted; **Understanding**: for people who know about the impacts of the changes to be adopted; **Acceptance**: for people who see the benefits of adopting the changes; **Readiness**: for people who have all the necessary knowledge and confidence to adopt the changes; *(people in the above four categories, even those in "readiness" status, have not yet implemented the changes)* **Sustainment**: for people who have adopted and set up policies or about to implement the changes
Community – External	These refer to the external parties, events, or substances etc., that would influence change implementations. They do not have any direct working relationship with the organisation or the personnel.
Community – Local	These refer to external parties, events, or substances that have working or other direct relationship with the organisation or the personnel, that would influence change implementations.
Environments	These refer to the situations, conditions etc. that might cause influences on change implementations. They are treated as subject substances instead of subject Attributes because themselves are the element imposing the influences. "Environment – individual organisation" refers to the environments within the organisation, and "environment – personal" refers to those of the individual. Similarly, "environment – individual discipline", "environment – technical" and "environment - non-technical" refer to

Analysis Related Terms	Description
	environments of the particular discipline, of technical related issues, and non-technical issues respectively.
External Propensity	This covers all the "external" subject substances that the person or organisation alone does not have much control but are having influences on change implementations.
General Attitude	For this paper, the term "general attribute" refers to people's manner or behaviour towards adoption of BIM.
General Attitude – classifications	The following are the four types of general attribute used in the paper: • **Conservative**: refers to people who have shown reservations in implementing changes for adopting BIM; • **Anxious**: refers to people who have shown their understanding about the need for implementing changes for adoption of BIM, but have worries, nervousness, or unease about the change implementation; • **Determined**: refers to people having the will or at the stage of being obliged to implement the changes for BIM adoption; • **Enthusiastic:** refers to people who have intense and eager interest, lots of self-motivation for implementing the change for adopting BIM, showing that they will undertake and/or insist for such implementation even not being requested or being opposed from doing so.
Locality	This does not refer to the physical location of the person or organisation, but the readiness of the personnel or organisation to implement the change.
Manageability	This refers to the extent of subject substances that are within the purview or under the controls by the individual person or the organisation.
Responsibility Level for "Major Responsibilities" Category	The "responsibility level" in this category refers to the level of influence by the group in implementing the changes. The highest level is assigned to the group who have the higher influence power in the change implementation.
Role Level for the "Roles in Implementing Change"	The levels assigned to the groups in this category follow the sequence of the elements in the ADKAR Model as follows:

Analysis Related Terms	Description
	Level 1: Awareness (the lowest level) Level 2: Desire Level 3: Knowledge Level 4: Ability Level 5: Reinforcement (the highest level)
Roles in Implementing Change	For this paper, the term "roles in implementing change" refers to the ways in which the interviewees are involved in the activities in change implementation for BIM implementation.
Roles in Implementing Change - categories	The names of the five elements in the ADKAR model is used as the category headings for the roles in implementing change. However, the definition of the roles here would not be the same as the original meaning of those in the ADKAR model. The five categories used to describe the people's roles are as follow: • **A**wareness: people under this category are aware of the need and/or reasons for the organisations to adopt the changes, but are not yet involved, or not in a position to be involved in the change implementation; • **D**esire: people who desire to implement the change and have participated in and/or supported the change implementations; • **K**nowledge: people who have the knowledge on what and how to change, and are involved in the provision of training or coaching for change implementations; • **A**bility: people who have the ability and are involved in implementing the changes; • **R**einforcement: people who are monitoring and reinforcing the changes to ensure that they are implemented to achieve the targeted outcome.
Strategy	The roadmap and intended movement for the changes to be implemented.

Building Information Modelling (BIM) Related Terms

BIM Related Terms	Description
Building Information Modelling (BIM)	BIM is not just a drawing tool but a new tool to holistically manage information relating to construction projects from the planning stage, to the stages of design, construction and operation. It is a new way of working, using new technology to facilitate project management and execution, better construction process control, cross-disciplinary collaboration, internal coordination, problem solving and risk management.
BIM Management	Management of data standards and data requirements to ensure reliable exchange of information for use in BIM.
BIM Model	The model created for use in BIM. A BIM model contains information of the geometry, spatial relationships, geographic information, quantities and properties of building elements, cost estimates, material inventories and project schedule etc. It will serve as a platform with provisions for storing, sharing and using of information by all parties during the BIM process.
BIM Processes	A series of events applying BIM technology to achieve the desired results. BIM processes involve planning and taking actions on what to be done, how it should be done and who will be doing it.
BIM Software	The authoring computer programme used to create BIM-related product, normally the BIM models.
BIM Technology	The application of BIM-related knowledge, skills and/or techniques to produce a product or to perform the works. It differs from "BIM software" in the sense that not only “software” is involved but the use of other technical knowledge, equipment, and tools etc would also be involved.

Change Factor and Analysis Related Terms

Change Factor and Analysis Related Terms	Description
Change	For this research project, the term "Change" is interpreted as "An act or process through which something becomes different, serving as the interface between the two segments "Subject" and "Object" matter in the sense that: "Subject" ⇔ "Change" ⇔ "Object"
Change Factor Compositions	The composition of the term "Change Factor" adopted for this research project is illustrated below: Subject Substance (SS) with Subject Attribute (SA) that influence, and subsequently imposed change (OC) upon Object Substance (OS).
Change Factor Elements	The segments used for breaking down "change factor". The segments are: Subject Substance (SS), Subject Attribute (SA), Object Substance (OS) and Change on Object (OC).
Object Change (OC)	The resulting "change" or "effect" in relation to the object substance after it has been influenced by the subject substance.
Object Substance (OS)	Things being influenced by subject substance.
Subject Attribute (SA)	The properties/function/capabilities etc of the "subject substance", meaning, the conditions, nature, status etc related to its influences imposed on the object substance.
Subject Substance (SS)	Things causing influences upon something else.

Change Management Framework (CMF) Related Terms

CMF Related Terms	Description
Adjusted Net Force Effects	The "Adjusted Net Force Effects" are the product of "Net Force Effects" and the "Influence Power Adjustment" factors input by the user. These adjusted force effects would be used to facilitate planning and allocation of resources for change implementations, taking into account of the user's desired adjustment.
Force Effect	This refers to the nature of the forces imposed by the change factor, i.e. a force driving towards implementation (D), or restraining (R) from changes. Each of them is assigned with the "force value". For the purpose of calculating the net effects, a positive (+ve) value is assigned to driving forces, and negative (-ve) value is assigned to restraining forces.
Force Value	"Force value" is the magnitude of force, in terms of numeric values, assigned to the "force effect" imposed by the change factor. A scale of 0 to 5 is used to represent the strength of magnitudes as follows: 0 = none/ not applicable 1 = very weak 2 = weak 3 = strong 4 = very strong 5 = dominating
Influence power Adjustment – reference factors	These are figured sample factors for references by the Change Management Framework (CMF) users. They are computed percentages based on the results from the researcher's surveys. After reviewing the actual situations, including the requirements, constraints etc, users may assign appropriate factors to each of the categories.
Net Force Effect	The "net force effect" is the net total of the values of all the "net force" for the change factors in the category. It could be defined as the result of subtracting the total value of the force restraining change implementation from the driving forces pushing forwards to implement the changes, which means: *Value of Net Force Effect =* *Value of Driving Force – Value of Restraining Force* After the subtraction, if the "net force effect" is a positive value, it would indicate that there are driving forces pushing

CMF Related Terms	Description
	forwards to implement the changes, thus facilitating achievement of target changes to be implemented. Conversely, a negative "net force effect" would indicate that there are forces resisting change implementation, acting as "restraining" forces from implementation of the targeted changes.
Net Force Effect – current and target	"Current net force effect" means the net force imposed by the change factors at the present situation. "Target Net Force Effect" refers to the anticipated net force that would be imposed by the change factor after reaching the targeted achievements.
Relative Influence Power Adjustment	These "relative influence power adjustment factors" are expressed in terms of percentages for users to apply as adjustments to the value of "net force effects". Applying an adjustment factor of larger than 100% to the original "relative ratio" of a category of change factors would raise its ratio and thus increase the value of its "net force effect". Conversely, the application of an adjustment factor smaller than 100% would lower the ratio and the "net force effect".
Relative Ratio	This is the ratio of the net forces of a category of change factors when compared with the others. It is calculated as follows: *Relative ratio = Value of net force of the particular category ÷ Value of the smallest net force amongst all categories* Absolute value of the net force values would be used. The objective is to show the relative weighting and thus the importance attached to each of the categories. The "relative ratio" for the category with the smallest value of net force would be 1.00, while the ratio of those with higher value of net force would be larger than 1.00.

Abstract

For construction works, right information shall be provided and received by the right parties at the right time. However, in reality, such precise information flow has not been achieved in all projects, resulting in deficiency in the overall performance efficiency. Such pitfalls in information flow in the construction industry have been in existence for long but seem inevitable.

A lot of literature have advocated that the adoption of BIM would be beneficial in various aspects. One of them is its capability in information integration, thus leading to the reduction in information flow problems in the industry. However, while BIM applications have already been used in the private sector of Hong Kong for over a decade, the pace in adopting BIM by the entire industry is still not satisfactory, even after the mandatory adoption by the Hong Kong SAR Government in 2017.

Construction industry is one of the most significant industries in Hong Kong. In the past several years, the average total value of construction works is about HK$148,200 million (around GBP 14,820 million) per year, at 6% of the GDP. It is one of the major elements in financial aspects and any changes in its performance efficiency would have substantial cost impact and effect on the economy. With the passion to contribute to the construction industry on improvements of the processes, the objectives of the research project are set to review and identify the change factors affecting BIM adoption processes, to examine and reveal how they could facilitate the construction industry to reap the benefits. To achieve the objectives, a Change Management Framework, backed by the results of the research findings and supplemented with recommended way forward in a structured approach, would be developed to enable users to proceed with effective and efficient BIM implementation processes.

The research processes start with secondary research by literature reviews to identify the factors affecting the implementation processes. Technological factors related to construction technology and management, as well as non-technological factors, such as those related to cultural and organisational developments, that would have influence upon BIM adoptions are covered in the review. Concepts and theories related to change models and management approaches have also been studied to underpin the researcher's capabilities.

Change factors for BIM implementations are of complexity and complicated in nature. For this, a change factor analysis approach is developed to enable structured analysis of the findings. The analysed findings are reviewed and transformed into meaningful and useful information for further use in the primary research, which consist of analysis of organisational change factors, and the advice obtained from interviews with BIM experts.

The tasks for achieving the research objectives, including the review on factors influencing BIM implementation and establishment of the Change Management Framework, have been completed. Users' guideline incorporated with step-by-step notes on the Framework setup and how would it be used to achieve the desired objectives has also been prepared. A case study with a trial run of the Framework has been conducted and the outcome proves that the Framework is ready for being used is able to serve the intended capabilities.

As one of the major contributions of this research project, the structured approach developed for identification and analysis of change factors, and the application of force effects on influence

powers being imposed by the various factors have enabled the identification of the source, nature and impact of the change factors in a holistic manner. By using this approach, despite the complexity nature of the construction industry, all-rounded analysis and identification of change factors, which is essential for BIM implementations, could be identified effectively.

In addition to the original target of facilitating users to proceed with BIM implementation processes, another contribution of the Change Management Framework is the capability introduced in blending of the technological and non-technological aspects. With such capabilities, the Framework would also enable users to implement the changes for other new technologies or processes, in an effective and efficient manner.

For future research, the established Framework could be extended to cover comparisons cross organisation or regions, and to form a base for research on change factors in a global manner. Results derived from the extended Framework and further research could be used to formulate appropriate benchmark indices and platform to facilitate effective implementations of Building Information Modelling world-wide.

In conclusion, the process of studying and researching, as a professional worker and a student at the University, has offered me a platform to gain more insights both in the academic as well as the professional world. In turn it has made the researcher looking at the work's issues not as unsolvable problems but as challenges that require cooperation, productive partnerships, and the acquisition of solutions.

Chapter 1 Introduction

This chapter lays down the overall rationale for this research project by introducing the development of Building Information Modelling (BIM) in Hong Kong, the "ought to" movement for adoption but with observed sluggishness. The research objectives, the motivations behind the research and the intended contributions are outlined. This chapter ends with a summary of the research focus, researcher's positionality and approach in pursuing the research project.

1.1 Project Brief

The objective of this research project is to review the effects and consequences of the benefits and barriers in implementation of Building Information Modelling (BIM), and to examine the extent to which the benefits could be strengthened and the barriers could be alleviated or eliminated as to achieve effective implementations of BIM. Both technological factors, for example, those related to construction technology and management, and non-technological factors such as those related to cultural and organisational development, that would have influence on changes implementation for BIM adoption will be covered in the study.

The research started with literature reviews and presentations by BIM motivating organisations, stakeholders, practitioners and personnel in seminars, conferences, forums etc., and published circulars, guidelines, policy addresses etc.

The findings were then reviewed, analyzed and summarized. Commentary and conclusions of the reviews were prepared so as to determine the objectives and the needs on change management. The findings from the review and the results would form the basis for development of a change management framework.

1.2 Project Introduction

1.2.1 Developments of Building Information Modelling (BIM) in Hong Kong

BIM applications have been adopted in the Hong Kong construction industry for more than a decade. The One Island East project developed by a private developer, Swire Properties, is considered to be the first project adopting BIM in Hong Kong (Ren and Kumaraswamy, 2013). The creation of BIM model of the project started in February 2005 and that the construction works were completed in March 2008 (Leung, 2011).

In January 2009, The Hong Kong Institute of Building Information Modelling (HKIBIM) was established, with a major objective to "*uphold and advance the standard of competence for the profession and to promote the interests and recognition of its members within the industry and community*" (HKIBIM, 2009, p. 1). The institute has been contributing a lot in promoting BIM applications in the Hong Kong construction industry. HKIBIM is a professional and independent organisation, managed and supported by BIM practitioners in the industry without receiving any government funding.

In 2013, another independent, private and non-profit organisation, namely buildingSMART International (Hong Kong) (bSHK), was established with the aim to "*improve sustainability of construction projects by introducing methods to build smarter through the implementation of latest open BIM technology*." (bSHK, 2013, p. 1). Most of the professional institutions in the construction industry, such as the Hong Kong Institute of Architects, Hong Kong Institution of Engineers, Hong Kong Institute of Surveyors, Hong Kong Institute of Facility Management, etc. have also gradually set up BIM Committee or Task Force and organized Continuing Professional Development (CPD) events on BIM-related topics.

In fact, most of the developments of BIM applications in Hong Kong have been led by the private sector in the construction industry. The Hong Kong SAR Government Departments have started exploring and promoting applications only in recent years. The "Roadmap for Building Information Modelling Strategic Implementation in Hong Kong's Construction Industry", published by the Construction Industry Council (CIC) in September 2014 is the first publication from a quasi-government body. In September 2016, a related publication from a statutory body, the Buildings Department of Hong Kong, which is responsible for the enforcement of the Buildings Ordinance in Hong Kong issued the "Practice Note on Building Information Modelling (BIM)". It is stated in the Practice Note that BIM models could be submitted as a kind of supplementary information for reference in the processes for approval of plans under the Buildings Ordinance.

1.2.2 Mandate for Building Information Modelling (BIM) Implementations

It was October 2017, as stated in the Chief Executive's 2017 Policy Address (Clause 113), that the Hong Kong Government initiated the action by "…*to adopt Building Information Modelling technology in the design and construction of major government capital works projects that are scheduled to start in 2018*" (HKSAR Government, 2017b). Eventually in December 2017, mandate of the use of BIM for Hong Kong SAR Government Projects was demanded in the Technical Circular (Works) No. 7/2017 issued by the Development Bureau (DEVB), in which it stated that starting from 1 January 2018, "*Capital works projects with project estimates more than $30 Million shall use BIM technology*". (Works Branch Developement Bureau Government, 2017, p. 3)

In the Hong Kong SAR Government 2018 to 2019 Budget Speech (HKSAR Government, 2018a), adoption of BIM technologies was again mentioned by the Financial Secretary on 28 February 2018. In Paragraph 113 of the speech, it was stated that "*starting this year, the Government will adopt building information modelling (BIM) technology in the design and construction of major government capital works projects*."

All the above would clearly indicate that the Hong Kong Government has had the desire, if not determination, to adopt BIM "technology". However, the wordings in Clause 113 of the 2017 Policy mentioned above "…*and promote the use of this technology in private construction projects*" implies that the Government realised that such technology was not yet wholly adopted by the private sector. This would mean that promotion of such use was required, despite the fact BIM has been promoted and adopted for use in the private sector of the industry for over a decade.

Furthermore, in the discussion paper for Construction Innovation and Technology Fund, the Legislative Council Panel on Development presented in May 2018 (HKSAR Government, 2018b) , under the heading "Technology Adoption in the Construction Industry", BIM is stated to be one of the Innovative technologies that would benefit the construction industry. However, it is also stated that "*these benefits notwithstanding, Hong Kong is lagging behind in the adoption of new construction methods and advanced technologies*" (HKSAR Development Bureau, 2018, p. 2).

The above would also suggest that the Government views BIM applications in Hong Kong are still "lagging behind". The mandate for adopting BIM technology would indicate that BIM was considered to be essential and vital by the Government, or otherwise, it would not mandate the use of BIM for government funded capital projects, and would not promote it for use in private construction projects.

In fact, similar mandates of the practice of BIM have also been made in many other countries earlier. The General Services Administration (GSA) of the United States has been requiring the use of BIM in all new projects since 2007. In Sweden, public organizations such as the Swedish Transport Administration has mandated the use of BIM from 2015 onwards. In 2016, the UK Government's construction strategy required that all centrally-procured construction projects should achieve BIM Level 2. In the same year, BIM was made compulsory by the Singaporean Government for all projects with value over S$50 million (HKD 280 million/GBP 28 million/USD 37 million) and for all public sector projects of any value. All these would further support the saying "*BIM implementation is essential*", and even "*a must*" as conveyed in the article "*BIM is a Big Boon*" (Yip, 2017, p. 6).

To conclude, BIM adoption and implementation is an important and inevitable task for the construction industry, and in fact be an "irreversible process". Research on how the processes could be properly proceeded to achieve the targeted objectives and benefits is therefore important, and that the findings would be beneficial to the industry as a whole. A study on the major factors forming barriers in proper implementation is also vital. If these factors are not well considered and properly addressed, they would form obstacles imposing "restraining forces" on the BIM implementation processes. On the other hand, thorough review of the validity of the advocated benefits would also be required as to reveal if such benefits are also perceived by the various parties and if they could be realized and forming "driving" force for BIM implementation.

1.2.3 Reflection

Implementation of BIM would be important, but its success would require much effort via thorough research, appropriate plan and development. The tasks involved would be difficult and complicated. Before proceeding, a review of the appropriateness of my positionality and adequacy of my capability ought to be carried out first. Below are the critical reviews.

1.3 The Researcher's positionality

Out of my 40 years of work experience in the construction industry, I spent most of my time providing services for a client organisation, the Hong Kong Polytechnic University (PolyU). The long journey of 35 years working at PolyU started in 1983. The work scope spanned from early planning, design, procurement, construction, to maintenance and operation stages. I have gained

knowledge in information management in an in-depth manner, for both new build and built assets, from the exposure.

1.3.1 Post-habitation works experience

In the first couple years, from 1983 to 1988, the works I handled for the PolyU were mainly asset maintenance and operation works, i.e., "post-habitation" works after completion of the buildings. The depth of the processes involved was relatively deeper when compared with those in the design and construction of new developments because:

(a) time span is longer as the processes would take place for the entire life cycle of the asset but not limited to the design and construction stages;

(b) most of the processes would need to be taken repeatedly and therefore, the demand for effectiveness and efficiency would be comparatively higher;

(c) most of the tasks have to be dealt with in a holistic manner, that is, they could not be shifted to others or be dealt with at later stages, as there is no other party to be "handed over" with the problematic areas.

With these repairs and maintenance works experience, I am equipped with the knowledge of what have actually been built in place and whether they have been built appropriately in meeting the targeted objectives. I am therefore in a good position to judge whether the information provided at the design and construction stages had been provided in a correct manner, in terms of appropriateness, adequacy, workability, buildability and maintainability. Knowing what should be present upon their completion, I am capable of providing appropriate information and identifying and judging if the appropriate information had been provided adequately, and to convince others to acknowledge the fact that I had the capability to do so, thus strengthening my authority in doing so.

1.3.2 New Phase: Start of Novel Projects

From 1988 onwards, I have shifted to take care of new project development works. Altogether I have handled 12 large capital projects for the University, with a total value of around HK$7,500 million, i.e., about £750 million, or USD 960 million, with a total area of about 304,000 m^2. (The projects are listed in Appendix 3: *Listing of Major Projects Handled*).

For the projects handled, I had to work with various different Government departments, users, design consultants, contractors, associated suppliers etc. As a key staff representing the client, one of the major duties is to ensure that the *right* information about the projects is provided and received by the *right* parties at the *right* time. In this regard, I had to handle different levels and nature of information at various stages, charged with the responsibility of managing them well, including necessary reviews, analysis, modifications, supplementing, and conveying to other parties for their follow-up actions and/or usage.

With such responsibilities and the associated involvement with various parties, I was given the opportunity to know not only the requirements of information (client side), but also those required by all the other stakeholders, including the designers, the contractors, the facility managers and also the auditing authorities. Furthermore, apart from knowing what was being required, I was also in a position (and in fact charged with the duty) to examine and comment on what key input had gone missing or not provided adequately by the various parties.

The above would serve to describe what I have learnt and how I achieved the necessary capabilities to perform my works. They could also indicate why I was in a good position to manage information, not only to provide it but also the authority to request it for enabling completion of the works.

Besides the large new project developments, I also handled various alterations and additions works being managed by in-house staff for design and project management. For such works, as contrary to the above, I was required to review for my colleagues if the contractors were asking for excessive information from the designers.

The above work experience and exposures located me in a quite unique position in terms of breadth and depth of the knowledge in information requirements. However, the works might not have been successfully completed if I did not possess the necessary academic capabilities.

1.3.3 Academic Background

I am a quantity surveyor. As one of the major tasks of a quantity surveyor, I have to process information from other parties, to transform them before providing it to others. These would generally include converting information from drawings, specifications and/or other media into a written document. Such documents would be used as base information for submitting tenders by contractors, which would subsequently become part of the contract to be executed by the contractual parties (i.e. the Employer and Contractor) and administered by the construction professionals (i.e. Architects, Structural Engineers, Building Services Engineers etc.).

As indicated in the Pathway Guides issued by the Royal Institution of Chartered Surveyors in 2018, quantity surveyors would have the inherited capability in information management capability: "*Quantity surveyors are the cost managers of construction. ... They must understand all aspects of construction over the whole life of a building or facility. They must have the ability to manage cost effectively, equating quality and value with individual client needs*." (RICS, 2018, p. 6)

The Higher Diploma and Advanced Higher Diploma in Quantity Surveying courses that I completed in 1977 and 1979, respectively, had provided me the following fundamental and essential information management knowledge in meeting the information management requirements:

a) information communication capabilities: the knowledge I was taught covered not only the quantity surveying profession but also those of the other parties in the construction industry, such as developers, planners, statutory bodies, designers, constructors etc., so that I could speak in their "language" so as to perform the required services.

b) information interpretation and transformation capabilities: I was taught how to interpret information from other parties and convert them into written documents (i.e. the tender and contract documents etc) which were ready for being understood and used by all the parties involved, even that the particular party receiving such documents might have little or not much knowledge in the subject area.

These are the most frequent and important processes that need to be done by quantity surveyors. The "interpretation" or "conversion" processes could only be performed effectively with such Information Management knowledge.

1.3.4 Consultant Works' experience

Before joining PolyU, I was employed by one of the largest professional quantity surveying firms in Hong Kong, Langdon Every and Seah (now known as the Arcadis Ltd). For the first several years working with them, I was assigned to handle post-contract services for some existing contracts. In order to perform the post-contract services, I had to study the source documents well, such as the drawings and specifications etc, the build-up of the quantities and the documents that had been used as the basis for compilation of the tenders and contracts.

From these documents, I learned what information had been used, how it was interpreted and compiled for the preparation of the contract documents and thus had in-depth understanding the requirements for how to prepare them.

As a summary, the information management processes involved by us quantity surveyors could be expressed as follows:

• Study and review what the information is available at the current state, i.e. the "Is" map

• Identify what are required but not yet provided, i.e. the gap

• Request, locate, or provide the necessary information as to ensure the information is complete and comprehensive – to bridge the gap, so that the "should be" state is achieved, i.e., the "Should" map

1.3.5 Further Enhancement on Academic Capabilities

On the academic side, my knowledge in the maintenance sector have been further developed and reinforced by the completion of the Master Degree in Construction Management (Building Maintenance) programme in Herriot-Watt University, United Kingdom in 1991. The attendance was supported by PolyU under a full-pay staff development programme.

I must admit that I was the most self-motivated to study for this MSc programme. I attended every class and I was the one who raised the most questions in nearly for all of them. I had been working very hard in completing the assignments and project works and after that, I was still not satisfied with myself so I spent my spare time on reading a lot of materials related to the building industry and in particular those related to Facility Management (FM). Learning with identified goals and self-motivations, again, had much extended my academic knowledge towards broader and deeper spectrum.

1.3.6 Facility Management and Building Information Modelling involvement

In the last several decades, I have been heavily involved in the Facility Management (FM) and Building Information Modelling (BIM) sectors.

For FM, I was one of the founding members in establishing the first overseas chapter of the International Facility Management Association in Hong Kong in 1992. After that I was serving as its Executive Committee Member for several years and organised various talks and seminars in FM related topics. Since 2004, I have been serving as the Council Member/Office Bearer of the local FM professional body, the Hong Kong Institute of Facility Management (HKIFM), and was elected as its President in 2013/14 and 2014/15. Since 2015/16, I am the Chairman of their Education and Membership Committee.

On BIM, after organising the first BIM in FM Conference locally in May 2011, I have been heavily involved in the promotion, education and research in BIM, and was invited to present talks in various seminars and conferences. Thus, my networking platform in this area has been widened substantially.

In 2013 together with eight other BIM experts/pioneers, we established the buildingSMART International (Hong Kong) (bSHK), with the main objective to promote and advance the knowledge of BIM locally and worldwide. In recognition of my status and knowledge in the area, I am elected as the Chairman of their Education and Training Committee. After that, I served as its Council member and was elected as Vice Chairman 2022/2024.

1.3.7 Network Exposure

The above contributions and involvements in the FM and BIM professional institutions would serve to demonstrate my capability, status in the construction industry and the authority to implement changes for improvements.

As my works with the people involved, including the academics, committee members of professional institutions and practitioners from various organisations etc. do not involve any commercial interest, I therefore have a platform for genuine sharing of views with them, thus the opportunity to understand the underlying problems being faced by each other, the constraints and difficulties being imposed etc. by different disciplines, at different levels at different stages. With this wide and close relationship network, my capability in accessing necessary information and securing support from the construction industry is ensured.

1.3.8 Reflection

My academic knowledge has equipped me with the capability to manage information, not only for my own profession but also those from others in the construction industry, and that I could communicate with them in the same language. With this competence and the sound information management skills learned from the consultant works' experience, I am equipped with the capabilities in handling the challenging and extensive works at PolyU. Without such, I might not in a position to manage the works well and gain the knowledge on the information to be provided in every stage of the life cycle of the construction processes.

In addition to my academic and professional knowledge and my unique position located by my working experience, my involvement and contributions in the Facility Management (FM) and Building Information Modelling (BIM) sector have located me in a non-commercial position, making me an ideal candidate to communicate with different parties, each with different objectives, views, constraints etc. This is particularly important and essential for successful BIM implementations as the changes involved need to receive recognitions and collaborations by all parties involved.

While there would be people in the industry that might have better capabilities than I do. I gather that I am in a unique and most appropriate position in advancing the use of BIM in the construction industry. In particular, regarding the aspects of information management, I am in a good position

in knowing what should be provided, and more importantly, what information flow problems and the reasons are found within.

My unique position in information management, Facility Management and Building Information Modelling could be summarised below:

Academic Background	Properly trained with the knowledge in information management
Work Experience	With wide and deep coverage in all stages of the entire life cycle, from early planning, design, procurement, construction, up to maintenance and operation stages.
Professional Knowledge	Multi-disciplinary with the capability to understand the requirements of all parties involved and communicate with them in the same language
Status	Pioneer in Facility Management and Building Information Modelling
Network exposure	With an extensive, wide and non-commercial network

In a nutshell, the background above has shaped my capability to offer the intended contributions, and explained my position in relation to my multiple identities in the construction industry. However, having the required ability does not necessarily mean that I must conduct the research. There are some solid reasons behind which urge me to pursue it. The driving forces behind will be covered in the following section.

1.4 The Research Context

The motivation for the research mainly comes from my recognition of the pitfalls in information flow in the construction industry, which have been in existence but inevitable for long. However, I could see that with the aid of Building Information Modelling (BIM), most if not all, the information flow issues could be resolved.

As a key staff representing the client side, one of the major duties is to ensure that the *right* information about the projects is provided and received by the *right* parties at the *right* time. However, in most of the projects I have handled, it is very often found that such proper information flows could not be achieved in full. In many of the cases, the information is not provided at the right time.

The information flow issue is not new. Bishop had already raised such problem in 1971, saying that while supposedly "*the design professions produce a complete and fully detailed design supported by specifications and bills of quantities*", the reality is that "*usually some details are available only after work on site has commenced*" (Bishop, 1971, p. 79)

Obviously such information issue would result in deficiency in time control, cost and quality of the project works. According to Bishop, one of the reasons behind the information flow problem

is that "*the building industry is fragmented, in that design and construction are usually undertaken separately, the former by firms of professional architects, quantity surveyors and engineers usually working independe*ntly" (Bishop, 1971, p. 79). In view of this complexity, Bishop also raised that "*Hence the importance, and growing importance, of a reliable, universal and efficient flow of information"* (Bishop, 1971, p. 79).

I consider that while the information flow is important, the mode of working attitude amongst the parties involved is more crucial. As a quantity surveyor, I realise that being the final handler of the compilation of tender documents, I ought to have all the information comprehensively covered in the documents. Thus, I have to deal with all issues of missing information and should not shift the problem to others. On the other hand, in case of doubts or discrepancies among the documents (drawings, specifications and Bills of Quantities), I am normally the first one to be consulted, if not challenged.

As an illustration, if a construction project is viewed as a football match, a quantity surveyor would always be treated as the defence team. The ball would be the tasks or problems, and we cannot leave it unattended. The issue is that in case if there is something wrong with the contract, (i.e. if the team loses in the football match), the defending quantity surveyors are always the party to be blamed, not matter if he is provided with the necessary information or not.

This bitter experience has not only enabled me to realise the importance of the information adequacy, but also the capability and authority of the information providers and receivers. As mentioned earlier, such information issues have existed for long in the construction industry unresolved. Such issues have been pushing me to find the solutions. However, before the introduction of Building Information Modelling, I could not see any way out that could achieve such target as covered in paragraph 1.4.2 below. After realising that Building Information Modelling would give us the chance to resolve some, if not all, of the issues, I am very much motivated to research on this aspect. More details are covered in paragraph 1.4.3.

1.4.1 Information Flow Issues – The Intractable and Untied Knot

There would be different types of information flow issues during the various stages of projects. Based on my work experience, the information could be categorised by their nature as follows:

- Inadequate: the information provided are incomplete and not fulfilling all the requirements of the receivers;
- Not the required one: the information provided are not relevant for use by the receiving parties;
- Not updated: revisions have been made but the information provided is not updated;
- Not linked to the right item: this differs from the non-updating issue as the information provided might be the most updated one but not for the appropriate item, e.g. the specification provided for window type A is actually for window type B;
- Blocked: the information is not provided to the recipient properly, or not received by the recipient properly, or that the information transmission is not done in a timely manner.

In addition, there should be one more category, namely "Adequate". However, in reality, this kind of information is very rare. In most cases, if not all, the information being provided fall within the above categories. As a result, there exist information gaps which would accumulate over the various stages of the project development processes. This could be illustrated in Figure 1-1 below:

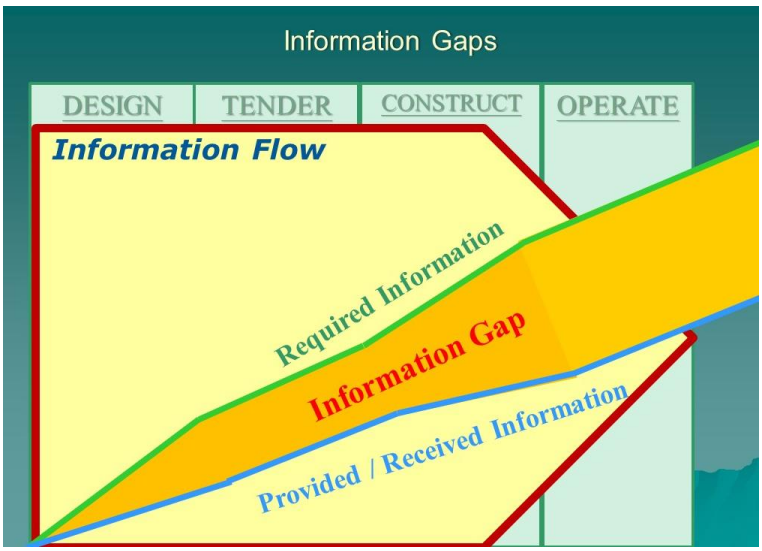


Figure 1-1 Information Gaps Scenario

There are many causes and rationales behind about such information flow problems. My understanding and knowledge for such have been shared in various presentations. For clarity, these are covered in the presentation extract, attached at Appendix 1: *Information Inadequacy – The Intractable and Untied Knot*.

After realising the potential benefits that could be achieved in information handling by using Building Information Modelling (BIM), I started exploring the ways BIM could be used in the construction industry to eliminate such information gaps issues.

1.4.2 The Dream, The Possible Dream

From my work experience, I understand that there are many interlocking and complicated reasons behind for the information flow problem. It would be difficult, if not impossible, to have all the gaps eliminated. Closing of the gaps by an individual only would be a kind of "dream" – i.e., a wish that could not be realised. However, as a professional practitioner in the field with expertise in information handling, with the work experience in a client organisation for more than three decades with due concern and diligences in handling information management, time, cost and quality of the project works, I have always been looking for chances to have the situation improved. I consider that the dream is in fact not only a "personal" wish of my own, but a kind of obligation to the industry as a whole.

As defined by the Oxford Dictionary of English, a dream is "*An unrealistic or self-deluding fantasy*." This definition also portrays the bitter experience in facing the information gap. Despite the attempts that have been made, the projects that I have handled did very often suffer from

information flow problems of different magnitudes and/or nature, resulting in different scales of adverse effects on time control, cost and quality.

However, another definition given by the same dictionary for "dream" is "*A person or thing perceived as wonderful or perfect*." In this regard, closing or narrowing the information gap is therefore something "wonderful or perfect" and this has been driving me to pursue further.

The gleam of hope in realising the dream comes with the introduction of BIM. After having involved in BIM promotions for some years, I could see that BIM would be able to bring much benefits to the construction industry in terms of various aspects, and in particular its ability in providing a platform for integrating and sharing information, and thus the possibilities in closing, or at least narrowing the information gaps.

1.4.3 Motivation for Research

The above would serve to explain the reasons for my passion to contribute to the construction industry by looking for improvements, in terms of being better informed by implementing Building Information Modelling (BIM). To achieving this goal, since in 2011, I started my first conference presentation with the topic: "*BIM for FM – A Client's Perspective" presented in the Hong Kong Institute of Facility Management*". In this presentation, I raised the issues to be considered and the problems that had actually encountered, with reference to real cases on information flow management. The talk was well received and soon after it, some audiences approached me for discussions and requested for further development courses and workshops.

These had encouraged me further and reinforced my belief to share the experience with others at the same time, no matter they are successful case studies or not, as they would be beneficial to the industry as a whole. To prepare for the presentations, I found that I ought to study and investigate more, and eventually after the presentations, I would learn more. I therefore continued to self-study, present and learn. For this, the list of the BIM/FM related presentations that I have done since 2011 in Appendix 2 : *List of candidate's professional qualifications, major committee/ office holdings, contributions and presentations*. This list would serve to show my involvements. From the list, it could be seen that the topics in these earlier years (2011 onwards) were focused on some elementary level in order to cope with the market conditions at that stage. In other words, at that time those were the leading topics.

1.4.4 Reflection

Sharing experience and knowledge with others would not result in any losses but benefits to myself, others and the related community instead.

The above reflection above could be supported by the saying (probably by Aristotle) that "*The more you know, the more you know you don't know*." Very often, after sharing views with others, I could realise that there are more topics I had not touched before and I ought to investigate and study in more depth. From these, I realised that some structured research with well-defined targets were required. After searching for appropriate further study programmes, I found that the Doctorate of Professional Studies programme offered by the University would equip me with the necessary academic knowledge and techniques in terms of breadth and depth, and also provide me the path to deliver contributions to the construction industry. In view of all these, I made the decision in pursuing the DProf programme in 2013.

As stated in my application for the programme, the major reason for selecting the programme is that it suits my requirements. In fact, soon after commencement of the project works, I already found that the programme would suit many practitioners who had the desire to contribute to the profession based on the experience acquired in the field but found difficulties in realizing the wishes.

Besides the growth in knowledge, the sharing has also reinforced my confidence in presentations of BIM-related topics. Since 2011, I have been invited for presentations to different sectors of the construction industry, not only within Hong Kong but also Mainland China and overseas. All these have increased my publicity and status in the field. I would say, if I do not have such confidence or standing, I would not be able to complete the primary research, the interviews and the difficult tasks to be performed for this project.

1.5 Objective of the project and Research Questions

1.5.1 Purpose, Aims and Objectives

In the review session for the DProf Programme in September 2014, Dr Kate Maguire gave a talk defining the differences between the terms ***Purpose, Aims*** and ***Objectives*** and their respective requirements and coverage.

The summary of the intention and coverage of each of these terms, based on my understanding, are as follows:

Purpose: It shall be concise with wide perspectives. It is notable that the purpose might not be fully achieved by only one project.

Aims: The aims shall be focused, targeting at achieving contributions to the **Purpose** to be achieved. There can be several **aims** under a **purpose.** Also, each of these **aims** might be covered in full by a particular research project.

Objectives: The objectives would concentrate on particular issues/ factors to be considered, covering the things to be achieved for a particular research project.

Based on the summary above, a schematic diagram of these three terms is shown below:

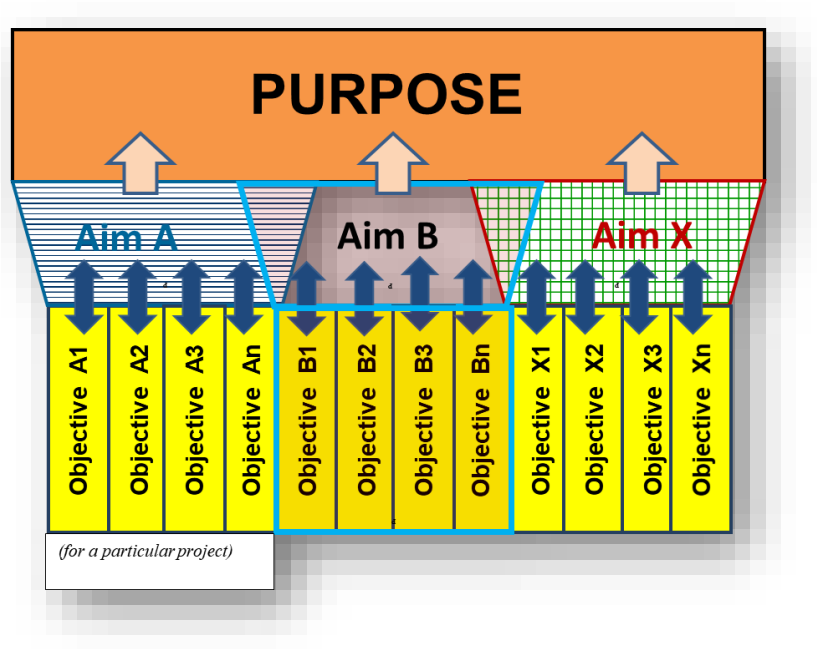


Figure 1-2 A Schematic Diagram of Purpose, Aims and Objectives

My interpretation is that while there may be many objectives with different focus areas, they should have a clear target to be achieved (the "Aim"). In the figure, bidirectional arrows are used to link the objectives and aims because it is considered that there would be iterative processes in between, that is, both the aim and objectives would need to be reviewed and refined until the aim is finally achieved. There would be overlapping area in the Aims and Objectives.

As an example, some of the objectives in Aim A may also be serving as part of those towards Aim B or other aims. Similarly, contributions from Aim A may have some common areas overlapping with Aim B or other aims.

On the other hand, such aim achievement would not be in a position to alter the purpose as a whole but could only contribute to the process. That is, the achievement of any aim would be beneficial / crucial to part of the purpose only. Therefore, one-way arrows are used in linking the aims to the purpose.

Following the rationale above, the purpose, aim and objective of this research project are defined as follow:

Purpose: Concise with wide perspectives

To facilitate improvements of the construction industry processes by effective implementation of Building Information Modelling (BIM).

Aim: Focused targets

The targets will be achieved by detailed and comprehensive review, evaluation, analysis and concluding the two types of forces putting forward for the implementation as well as limiting the movements, being imposed by the benefits and barriers, respectively. With such holistic review,

the key features, capabilities, maturity etc. in achieving the BIM benefits could be identified, and the factors are not classified as barriers but have impact on BIM implementation processes could be better understood.

The findings would further be developed to contrast with the situations in Hong Kong before and after the Government's mandate of BIM use as:

- to enable stakeholders, practitioners and all stakeholders concerned to understand the scenario and in particular caution items for BIM implementation;
- to establish effective implementation plans and framework for use by individual organizations, distinct disciplines and individuals at all phases of the entire asset life cycles;
- to facilitate establishment of a roadmap appropriate for being considered by the industry for future implementation.

Objectives

For this research project, a study of the following particular issues/factors would be conducted:

- to review and identify the underlying barriers in BIM implementation that have been in existence, those still exist and newly arisen after the mandate of BIM use by the Hong Kong SAR Government;
- to review and evaluate the rationales behind the existence and the impacts of such barriers on the BIM implementation processes;
- to review and analyze practical problems and influencing factors that would have effect on successful BIM implementation processes;
- to review other non-technical factors such as cultural and organisational developments etc. and the theories and concepts behind that would need to be considered in managing the changes imposed from BIM implementations.

The results of the above reviews would be analysed and concluded. A change management framework would be formulated for the recommended way forward and approach, with the following objectives:

- to alleviate the adverse effect of the barriers or problems;
- to effectively manage the changes as to ensure effective and efficient BIM implementation processes;
- to facilitate the construction industry to achieve the potential benefits of BIM.

1.5.2 The Research Focus

BIM is chosen as the research focus of the study because while BIM is considered to be an important change with much benefits, the pace for adoption in the industry has been sluggish, not only in Hong Kong but worldwide. As one of the findings from the literature review, it is said that "*many of the parties involved are still finding their feet in and industry where BIM compliance can bring great rewards*" (Pittard and Sell, 2016 - cover page). My involvements and experiences in BIM developments also reveal to me that there are various problems and hurdles that need to be overcome, in particular the changes to be faced during the implementation. Furthermore, the problems and hurdles would not be of simple or standard nature but would be varied in different stages of the asset life cycle, and for different disciplines and capacities of parties in the industry.

1.5.3 The Research Questions

In order to find out how the industry could be able to have improvements with BIM adoption, I would carry out studies to find out the answers to the following research questions:

- What are the benefits and barriers in BIM implementation in the construction industry?
- What are the technological and non-technological factors and how are they affecting the BIM implementations?
- How does each of these factors enhance or hinder potential improvements?
- Why do these factors have such influencing power?
- What are the relationships between these factors?
- What is the net resulting driving up/ pressing down force? Could such net remaining force be determined and improved?
- How has the mandate on BIM adoption affected these forces?
  For this particular research questions on mandate, there are sub-questions as follow:
  - for downward pressing forces imposed by barriers and resistances: is it true that not all the barriers could be removed or if only some of them could been removed/ reduced after the mandate?
  - for upward driving forces: what are they and how are they driving up to the target, and are there any changes to them after the mandate?
  - if there are any new barriers, how would they affect BIM implementation?
  - Have these other factors been affected?

My anticipation is that while the magnitude of the effect and/or nature of each individual barriers might have been changed, these barriers would still be exercising certain adverse effects on BIM implementation, thus hindering the achievement of the anticipated benefits. In terms of benefits, the financial support from the Government on BIM implementation would certainly be one of the major additional short-term benefits. However, the medium and long-term benefits perceived by individual disciplines might not bring about many changes. In any case, all these, including other factors, would need to be well examined and a holistic study would be required to find out the actual situations.

The study would also target at identifying the changes after the mandate. However, before making comparison for any changes, the original situation must be well studied or otherwise the changes could not be identified.

The research project to be undertaken is to carry out an in-depth review of the factors in Building Information Modelling (BIM) implementation, taking into account the effects that would or have imposed by the mandate.

Findings from the review would be analyzed, concluded and incorporated in a change management framework for consideration and use by the industry. The framework would be pragmatic, providing unbiased and factual findings, clear and concise summaries of the research results and recommendations. The recommended approaches would be practical and feasible, or at least be convincing and being considered as experimental by the industry. Anticipated expectations that are perceived to be too unrealistic, or perfect or ideal targets perceived to be intangible would not be welcome by the pragmatic construction industry and their practitioners.

As an attempt to reflect the different scenarios and updated situations, the differences and similarities in terms of validity and scale of influences of each of the following to different parties would be identified and summarised to form part of the framework for consideration by the users:

- the "believed" benefits/barriers/change factors: that is, what are the factors considered to have effects on BIM implementation processes. These would be obtained mainly from literature reviews, supplemented with those from the interviews conducted for this research project;
- the "perceived" benefits/barriers/ change factors: that is, how are these being considered by the various parties. Are they commonly agreed by all of the parties involved?
- the "anticipated" benefits/barriers/change factors: that is, what are the scale of influence (or the scale of the upward/depressing driving forces) being considered by the parties.

Different parties possess capabilities, requirements and expectations, and in particular, different business objectives. Their perceived and anticipated value of each of the factors might be different. Since cross-disciplinary collaboration is one of the major processes being used in BIM, due consideration in how these factors is being viewed by different disciplines parties would be necessary.

1.5.4 Contributions - Influences on Academic Knowledge and Capability

After commencement of the process of literature review, I found, and eventually understood that in the reality of life, there are a lot of complex and complicated issues that need to be conceptualized. In particular, in the construction industry, there are various factors affecting the pace of BIM implementations due to differences in perception, knowledge, objectives and cultural mindset etc. among different individuals, disciplines and organizations. Also, these differences might also vary between the local community, external and other communities. In this regard, my research project would need to be positioned in a wider context.

With the increased extent of the knowledge coverage, the breadth and depth of the requirements to be fulfilled for the research project have also been escalated. The main research focus, initially on technology issues of benefit and barriers, has eventually been extended to cover other factors and theories about change, such as the Cultural Knowledge Model, Force Field, Processes, Planned/ Organisation Development (OD) approach, Emergent Approach, concepts of transdisciplinarity and related approaches, etc. All these extensions have enhanced my knowledge and would form part of the contributions to the industry in the manner of "From Theory into Practice" upon completion of the research project. This would be elaborated below.

1.5.5 "From Practice into Theory" or "From Theory into Practice"

As a practitioner in the construction field for four decades, I do have learnt a lot from the practical work experience. However, as a regular practitioner I have unconsciously treated all the practices in the investigations, review, analysis, reports, advice and decision-making processes etc. for resolving the day-to-day project problems or issues are just routine and normal tasks to be performed. I do not expect these practices to be, or worthwhile to be, well-recorded, disclosed or shared with others.

Another "practical" experience is that when dealing with change implementations in the work environment, very often I find that I have to counter much resistance and suffer from the depressions or unhappiness afterwards. I have treated these occasions as normal cases and just continued to tackle them case by case, while very often felt disappointed or depressed by the repeated occurrence of such resistance again and again. This is in line with the saying by Gonçalves given in his book that change is not made without inconvenience, even from worse to better. (Gonçalves, 2007).

However, with the rewards (not necessarily monetary but the feeling of satisfaction) from the successful cases, I began to note that the unhappiness could be easily and simply written off after the change was successfully implemented in line with my anticipations. Also, I found that while much effort would be required to encourage others in making the changes, after making such advancement to others, I would also be further improved.

Given the above rewards, I have gradually changed my mind set and wanted to share my experience and knowledge with others. The objective is to help or assist others to realise the issues and then equip them to implement changes for improvements in a satisfactory manner.

As an initial thought, I expected that the knowledge sharing could be achieved by simply converting knowledge learned from "Practice" into "Theory" so as to enable the knowledge transfer and distribution. However, later I found that prior to such conversion, much resources, not only in terms of time and money, but also underpinning support from existing theories are also required. Understanding of the recipients' requirements or anticipation are essential for finding the appropriate and specific ways in selecting, in order to explain the knowledge to be shared, and to convince others to adopt them.

In this context, the path for practical knowledge sharing is:

"Practice + Theories" → "Theories for Practice"

More detailed description of the theories studied and how they are analysed, selected and applied to the proposed change management framework in line with the above path are covered in paragraphs under 2.5 Changes Theories. These studies, coupled with the knowledge from my work experience, would underpin the development of the change management framework (theory) for effective BIM implementation (practice).

1.6 Summary

With change factors in BIM implementation as the research focus, in terms of coverage, the breadth of the proposed research project is considerably wide because factors in all the different stages in the construction processes would need to be reviewed. The depth would also be deep as the changes are imposing on various parties, from different disciplines and working at different levels. My extensive work experience, with involvements in all the life cycle stages have enabled me to identify and interpret the problems being faced. My involvement in the construction projects handled and the services offered to professional institutions in the construction industry have enriched my connections with parties of various disciplines, ranged from very senior management level to hands-on operational level, in the construction industry. With these background abilities and capacities, I would be in a position to access the necessary information for carrying out the

research project, to disseminate the research results and use them to exercise influences for sake of making changes and improvements in the construction industry.

1.7 Researcher as Insider Researcher

For this research project, I would be an insider-researcher, who is researching and developing aspects of my work practices and being a change agent in my professional community.

In this research project, I would be involved more in the capacity of a detached observer, so as to provide unbiased observation and recommendation, rather than an interested participant only. This will mean that I would be writing myself into the research and showing, rather than hiding, my influence upon what I am reporting on. More details of the proposed approach and my capability would be covered in Chapter 3 Methodology.

1.8 Reflection

For the adoption of Building Information Modelling (BIM), a lot of literature advocating the benefits have been published, a lot of promotion has been done by the private sector, and in 2017 mandate for the use of BIM was required by the Hong Kong Government. All these indicated that the adoption of BIM would be beneficial to the construction industry, and that this is an important and inevitable task, and even an irreversible process in the industry. However, in reality, the pace for adoption has been found to be sluggish, not only in Hong Kong but worldwide.

As an experienced practitioner in the construction industry, I do understand that there are many complicated reasons behind such sluggishness. I also realise that while I have the passion to contribute to the construction industry with improvements by implementing BIM, with only my own experience and pre-existing knowledge would not be adequate to achieve the target. In this regard, some sort of enrichments are required. As a start, the processes of mastering existing knowledge would be taken in order to enrich my knowledge in what have been said, what have been done by the others on BIM implementations. This part has been done by means of literature reviews. The works done and findings will be reported and discussed in the next Chapter. Coupled with these, the next Chapter will also cover further review on relevant areas, in particular the aspects of Information and People within the purview of BIM, the theories and the criteria to be considered for change management.

Chapter 2 Literature, Knowledge and other Information Review

This Chapter would cover review of the literature on published or presented knowledge in the subject matter, Building Information Modelling (BIM). As part of the research processes, further review on related areas, in particular the aspects of Information and People within the purview of BIM, the theories and the criteria to be considered for change management would be covered. The findings would be used as a basis for the establishment of the change management framework. Details of such would be covered in the subsequent chapters.

2.1 Literature Review

Literature review is an essential part of a thesis. It is where the researcher discusses and reviews the studies, perspectives, theories and bodies of work relevant to the research questions and, throughout the process, demonstrate the gaps or shortcomings in previous research that the researcher's work will fill (University of Wolverhampton, 2018). This implies that the literature review results shall not only be generic reviews of the literature but will be referenced in the research project. Following this approach concept, this Chapter would largely focus on the "use of literature" rather than only "literature review".

The following quotes from H.M. Cooper by Rowena Murray (Murray, 2006) would be relevant and useful in explaining the coverage of this Chapter and distinguish it from the rest of the thesis:

> "*First, a literature review uses as its database reports of primary or original scholarship, and does not report new primary scholarship itself…"*
> "*Second, a literature review seeks to summarise, evaluate, clarify and/or integrate the content of primary reports"* (Cooper, 1988, p. 109).

In line with the above, this chapter would cover the primary research results. As part of the research processes, a secondary research would be carried out for further review of literature on published or presented knowledge on the subject matter. The findings would be used as the basis for establishment of the change management framework. Details of such would be covered in Chapter 4 or Chapter 5.

However, in addition to the background information reviewed, the researcher's own knowledge would be included as to relate the findings to the following:

- importance of the construction industry in Hong Kong,
- the need for improvement and change for adopting Building Information Modelling (BIM),
- the processes involved, and
- the change factors need to be considered by the industry.

Reviews of the technical and other factors affecting the BIM implementation, the theories and the criteria to be considered for change management would also be covered. The objective is to establish a change management framework to facilitate the construction industry in Hong Kong to improve processes to achieve faster and efficient processes by effective implementation of BIM.

2.2 Construction Industry in Hong Kong

2.2.1 Significance of construction works

The first part of the literature reviews would cover those related to the need for improvements in construction industry of Hong Kong, which is the objective of this research project.

Construction industry is one of the most significant industries in Hong Kong. As commented by the Construction Review Committee, "*the construction industry is one of the main pillars of Hong Kong's economy. In 1999, it accounted for 5.6% of the GDP*…" (CIRC, 2001, p. 1). Its significance did not only exist in 1999. From 2014 onwards, the total value of construction works continued to account for around 6% of Hong Kong's GDP, as shown in the table below.

		Gross Value of Construction Works			
Year	Gross Domestic Product (GDP)	at Private sector sites	at Public sector sites	Total Value	% of GDP
	HK $ million	HK $ million	HK $ million	HK $ million	
2014	2,260,005	53,953	**68,824**	122,777	5.4%
2015	2,398,280	67,781	**77,242**	145,023	6.0%
2016	2,490,617	77,666	**81,367**	159,033	6.4%
2017	2,662,836	74,945	**87,855**	162,800	6.1%
2018	2,842,883	75,552	**75,856**	151,408	5.3%
(average)	*2,530,924*	*69,979*	***78,229***	*148,208*	*5.9%*
2019 Q1 & 2	1,410,558	35,772	29,965	65,737	4.7%

Table 2-1 Comparison of Gross Domestic Product (GDP) with Gross Value of Construction Works in Hong Kong

Source: Gross Domestic Product, Third Quarter 2019 (Census and Statistics Department Hong Kong SAR, 2019a) *and Report on the Quarterly Survey of Construction Output, Second Quarter 2019* (Census and Statistics Department Hong Kong SAR, 2019b)

It could be noted from the above that the average annual output in the last five years (2014-2018) is around HK$70,000 million (around GBP 7,000 million) in the private sector, HK$78,200 million (around GBP 7,820 million) in the public sector, with a total of HK$148,200 million (around GBP 14,820 million) per year.

Moreover, the Gross Value of construction output for works at the public sector would be increased substantially in the coming ten years. In line with the Government Policy 2018, in the "Construction 2.0 – Time for change" (Development Bureau, 2018) issued by the Development Bureau, it is stated that "*over the next 10 years, construction investment of approximately HK$2.5 trillion to HK$3 trillion is expected* …." (p. 2). That is, the average value of construction would be around HK$ 250,000 million to HK$300,000 million per year which is about 3.2 to 3.8 times of the average of HK$79,000 million in the last 4 years.

Besides the amount of investment, the paper also advocated that "*the construction industry has played a key role in positioning Hong Kong as one of the most recognizable, dynamic and admired cities in the world*" (Development Bureau, 2018, p. 2).

Construction industry is therefore inevitably an important aspect not only in terms of financial significance but also the global standing of a country or region, the effectiveness of the industry would also be important. In the Construction 2.0 booklet, it is indeed stated that improvements in the industry are required as in the recent years the industry has witnessed a series of incidents such as unsatisfactory cost performance, commissioning delays, site safety incidents and also quality of construction delivery. This further indicates that any means that have the ability to enhance the industry performance would also be worthwhile for being well considered.

2.2.2 The need for improvements

The above reveals that the construction industry is inevitably an important aspect not only in terms of financial significance but also the global standing of a country or region, the effectiveness of the industry would also be important.

In the covering letter (p. 1) of the "Report of the Construction Industry Review Committee" , the Committee Chairman has already appealed that "*The (construction) industry must enhance its competitiveness through continuous improvements*" (CIRC, 2001). Such "*continuous improvements*" are still required as about twenty years later, in 2018, the Construction 2.0 paper (Development Bureau, 2018) still advocates that improvements in the industry are required in recent years the industry has witnessed a series of incidents such as unsatisfactory cost performance, commissioning delay, site safety incidents and also quality of construction delivery.

Even without such incidences, the value of works involved in the construction industry itself already serves to signify the need for uplifting the performance efficiency as the changes would have substantial cost impact and effects on the economy.

Based on the assumption that the annual output in the private sector would remain unchanged, the total value of output in the next ten years would be HK$70,000 million + HK$250,000 million (the lower range value of anticipated public works) would be within the range of HK$320,000 million. If there is 1% change in terms of cost effectiveness, the overall cost effect would already be in the range of HK$3,200 million (approximately GBP 320 million).

The above situations are not unique in Hong Kong. The percentages of GDP for construction industry are also high: "*Globally, the construction industry is responsible for between 3 to 10 per cent of GDP if only the raw site-based construction activity is considered, but importantly between 10 to 30 per cent of a country's GDP if the broader construction supply network definition is used*." (Hampson, Kraatz and Sanchez, 2014- Chapter 2, p.5). For this, the authors also advocated that construction industry in many countries would need improvements in "*performance and productivity such as: just-in-time delivery; partnering with suppliers; supply chain management; off- site manufacturing; and most recently advances in digital information and communication technologies.*" (Chapter 2, p.4). However, they also pointed out that "*Despite its size and importance to the economy, the construction industry has not kept pace with other large industries in productivity improvement.*" (Chapter 2, p.4). These situations would also be applicable to the construction industry of Hong Kong.

2.3 Building Information Modelling (BIM)

From the above, it could be observed that the demand for improvements in the construction industry has been obvious. Literature reviews below would show that implementation of Building Information Modelling would lead to improvements to the construction industry as its implementation would result in many benefits in various aspects and be an approach that could lead to meet the demand for improvements. However, as mentioned in Chapter 1, given such perceived benefits, the adoption of Building Information Modelling in the industry had been sluggish. It is necessary to have reasons behind be reviewed and analysed, but prior to these, a study of the developments and factors affecting the implementation ought to be carried out.

Besides the benefits, this section would also cover the background information related to Building Information Modelling, its development and adoption in Hong Kong and other countries. Coupled with the reviews of the technical and other factors affecting the implementation, the theories and the criteria to be considered for change management, the review findings, etc., would form the basis for the proposed change management framework to be developed in this research project.

2.3.1 Building Information Modelling (BIM)

Since the term "BIM" is one of the major and important terms used in the research project, it is necessary to have its definition well-established before conducting the review and analysis. As stated by Saraireh and Haron (2020), "*There are many definitions and explanations for building information modeling have been introduced*" (Saraireh and Haron, 2020, p. 166) . In fact, there are various definitions prepared by different bodies at different country for BIM, each with similarities or differences in focus, coverage and/or objectives. Also, the definition would evolve with time upon developments of the BIM applications. This is why it is commented that "*The term BIM continues to evolve over the years* …. " (BIM Dictionary, 2022).

After review, I would consider that amongst the various definitions, the following two would be appropriate for being adopted for use for this research project:

a) "*Building Information Modelling (BIM) is a set of technologies, processes and policies enabling multiple stakeholders to collaboratively design, construct and operate a Facility in virtual space*" (BIM Dictionary, 2022);

a) "*BIM is not just a drawing tool but a new tool to holistically manage information relating to construction projects from planning stage, to design, construction and operational stages. It is a new way of working, using new technology to facilitate project management and execution, better construction process control, cross-disciplinary collaboration, internal coordination, problem solving, and risk management*" (Hong Kong SAR Construction Industry Council, 2014, p. 17).

These two definitions are considered to be the most appropriate for use because the following major and essential usage and coverage of BIM are covered:

- in terms of technology and process: BIM is a new tool to holistically manage information
- in terms of people: BIM involves cross-disciplinary collaboration

- in terms of time: BIM spans from planning stage, to design, construction and operational stages, i.e. covering the entire building life cycle
- in terms of policy: BIM enables multiple stakeholders to collaboratively design, construct and operate a Facility

Furthermore, being the organisation assigned by the Government for promoting and encouraging BIM implementation, HKCIC's views as covered in definition (b) could be construed as a reflection of the construction industry local context in Hong Kong.

2.3.2 Building Information Modelling – The Fundamentals

However, the above definitions may appear to be too abstract, and the meaning might not be easily perceived by stakeholders, in particular those who have not been involved in the BIM processes. For this, the following extracts from my "BIM ice-breaking" presentations might lead to a simpler definition and fundamental concepts of Building Information Modelling:

"*Building Information Modelling could be interpreted as the use of a new technology in presenting building objects in three-dimensional (3D) models so that they could be easily visualised. Also, with this new technology, necessary information, such as material specifications, related documents, etc. are linked to the models."*

In the traditional approach without BIM, the building objects are presented in two-dimensional (2D) drawings, such as plans, elevations and sections separately. These drawings are often supplemented with one-dimensional (1D) documents such as specifications, manuals, forms and schedules etc. In between these 2D drawings and 1D documents, there is no automatic linkage. The information about the building objects is fragmented and separated from each other.

With the application of BIM, each of the building objects (the model) has its own identity, and could be embedded with its own properties, the information provided would not be lost and could be easily amended/updated/retrieved correctly. Information changes due to any amendment of the models could be updated and shared/used by all the parties at the same time, without any time lag. The information flows would therefore be improved, and the risk of information error could be avoided or at least reduced.

Besides the improvement in information flows, the other major advantage of adopting Building Information Modelling is that the 3D presentations would enable all the parties involved, such as the client, contractor, and service providers to visualise the building works before their completion in a 3D mode. This would enable each party to comprehend details of the works thoroughly and facilitate them to comment, construct, operate or maintain the works in a more effective and efficient manner.

2.3.3 Acronym "BIM" explained

Since the acronym "BIM" is not only the abbreviation for Building Information Modelling but also for Building Information Model and Building Information Management, confusions might occur. In fact, each of the terms would have different coverages. Below are the explanations of each of these terms.

2.3.3.1 Building Information Model

Building Information **Model** is a three-dimensional (3D) virtual model, being used as a tool to help in presenting what are there (the objects), storing and retrieving information about the objects.

As an example, in traditional 2D drawings, four different objects would be shown on plan as shown in the figure below:

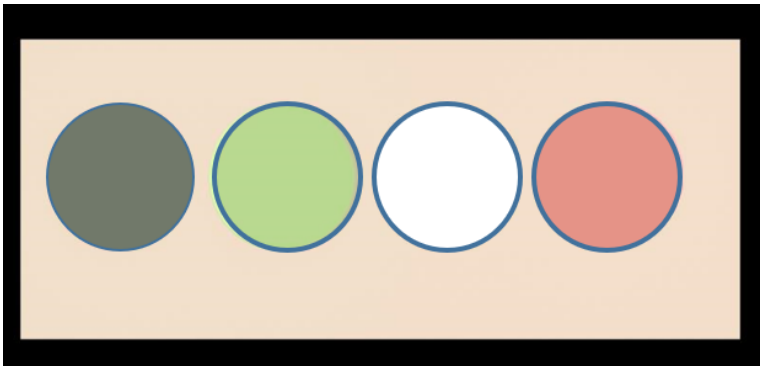


Figure 2-1 Traditional 2D presentations

Since all of them would look the same, further supplements, such as side elevations or descriptions etc would need to be added in order to differentiate these objects.

If a three-dimensional (3D) model is used, the differentiations of the objects could be visualised easily, as shown in the figure below:

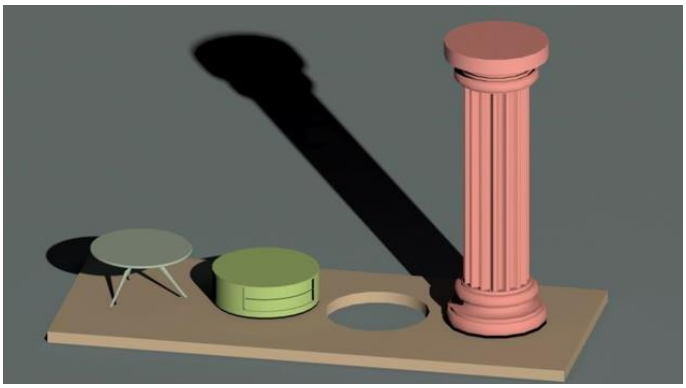


Figure 2-2 Three-dimensional (3D) presentations

As a start, the Building Information Model could be interpreted as a three-dimensional (3D) model for presentation of a building object. However, in Building Information Modelling, the presented object is not only a geometrical model, but also a model with embedded information:

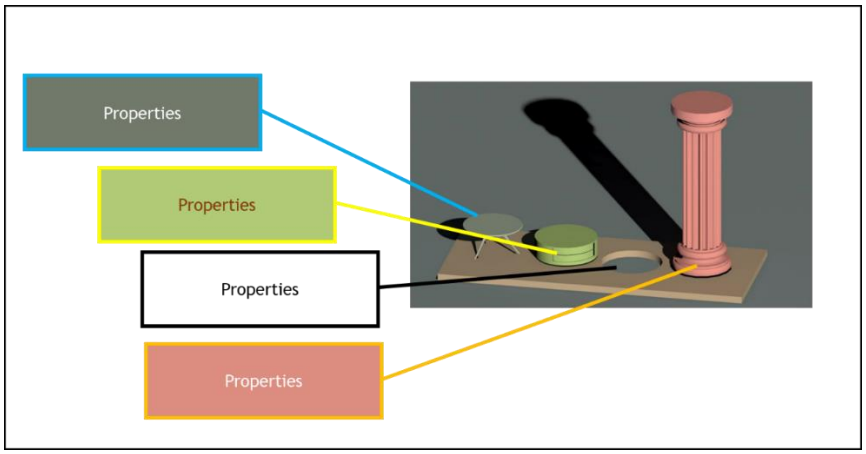


Figure 2-3 Three-dimensional (3D) Model with embedded information

The 3D models are created with newly developed authoring software, enabled with the capability to embed associated properties/ information. For objects with the same type of construction, each of them would have a unique identification code and database behind for storing of its own properties. The properties could be information about the object, such as its location, material of construction, name of manufacturer, cost and date of purchase, life span, maintenance/ replacement records, etc. These properties could also be linkages to external database such as web pages, files of detailed specifications, operations and maintenance manual etc. The properties or linkages could be used as the basis for reporting, analysis etc., and could be easily retrieved by all users by just clicking the 3D models on the computer screen.

In short, a **Building Information Model** may be regarded as a three-dimensional model serving as the presentation for a building object with a database for information storage and retrieval.

2.3.3.2 Building Information Modelling

Building Information **Modelling** is different from Building Information **Model** in the sense that it is a process. In "Modelling", the processes in creating, managing, using and sharing of information of the **Models** are covered.

As a metaphor to illustrate the difference, let us review the difference between "Report" (model) and "Reporting" (modelling). A "**Report**" would serve to describe information about something or some activities. Upon completion, the contents of the report would be finalized. In case there are updates or amendments, a separate report shall be prepared. The new report generated will be different from the previous one. In this sense, each report is unique in terms of contents and time of completion.

In "**Reporting**", the processes of creating, amending or updating of the reports are covered. The processes would be continuous until the final report has been prepared. In other words, in "**Reporting**", there might be more than one report created and used at different stages. Similarly, in "Building Information **Modelling**", there would be more than one "Building Information **Model**" to be created and used at various stages.

2.3.3.3 Building Information Management

"Building Information **Management**" simply could be interpreted as the processes in managing information about buildings by using Building Information Modelling.

2.3.4 Usage of the term "BIM"

For the purpose of this research project, when the acronym "BIM" is used as a noun, it would be referring to the term "Building Information Modelling" only, while the other terms with the same acronym, such as "Building Information Model" or "Building Information Management", the term would be given in full to avoid unnecessary confusion.

When the term BIM is used as an adjective, it would mean the attribute of the noun following it is related to BIM. For example, "BIM Model" would be referring to the "Model" being used in BIM, and "BIM technology" would mean the technology being used in BIM etc.

2.3.4.1 BIM Model defined

The definition of the term BIM model adopted for use in this research project would also follow the one being quoted in the Roadmap for Building Information Modelling Strategic Implementation in Hong Kong's Construction Industry (Hong Kong SAR Construction Industry Council, 2014) as follows:

> "*A building information model contains information of the geometry, spatial relationships, geographic information, quantities and properties of building elements, cost estimates, material inventories and project schedule. This model can be used to demonstrate the entire building life cycle*." (p.17)

As a supplement, a BIM model shall serve as a platform with provisions for storing, sharing and using of information by all parties during the BIM process.

2.3.5 The trend of BIM usage

As commented by Jones and Bernatein (2014), BIM has been evolved to a "*must-have*" tool: "*BIM, which began primarily as a design tool then evolved to a must-have for leading contractors, is now rapidly gaining traction with owners around the world*". (Jones and Bernatein, 2014, p. 4)

In the Hong Kong context, as mentioned in Chapter 1 paragraph 1.2.2, in 2017 the Hong Kong SAR Government addressed the mandatory adoption of BIM technology for public capital projects from January 2018 onwards. Also in the paper on Construction Innovation and Technology Fund (HKSAR Government, 2018b), BIM is stated as one of the innovative technologies that would benefit the construction industry.

In fact, BIM is the new trend in the construction industry worldwide and is being mandated by other governments. According to Chen et al. (2017), " *BIM has been under aggressive promotion by governments throughout the world*" (p. 1007). This observation is also raised in the "Roadmap for Building Information Modelling Strategic Implementation in Hong Kong's Construction Industry", saying that "*The United States, the United Kingdom, a number of major European*

countries, Singapore and South Korea have mandated the use of BIM in public construction projects. A number of countries will require BIM to be adopted in the near future". (Hong Kong SAR Construction Industry Council, 2014- Executive Summary p. 1).

All these have the indications that the industry or governments have realised the benefits of BIM and therefore adopted its applications.

From the above, it could be observed that the "BIM wave" has come and that eventually it has been, or will soon be, adopted by the construction industry not only in Hong Kong but globally.

The following are the reviews of the developments and status of BIM adoption and implementations.

2.3.6 Developments of BIM usage in Hong Kong

BIM applications have been applied quite early in Hong Kong, as traceable from 2005. The One Island East project developed by a private developer, Swire Properties, is considered to be the first project adopting BIM in Hong Kong (Ren and Kumaraswamy, 2013). The creation of BIM model started in February 2005 and the construction works were completed in March 2008 (Leung, 2011).

In January 2009, The Hong Kong Institute of Building Information Modelling (HKIBIM) was established, with a major objective to "*uphold and advance the standard of competence for the profession and to promote the interests and recognition of its members within the industry and community*" (HKIBIM, 2009, p. 1). The institute has been contributing a lot of efforts in promoting BIM applications in the Hong Kong construction industry. It is a professional and independent organisation, managed and supported by BIM practitioners in the industry but not funded by the government.

In 2013, another independent, private and non-profit organisation, buildingSMART Hong Kong, was established with the aim to "*improve sustainability of construction projects by introducing methods to build smarter through the implementation of latest open BIM technology*." (bSHK, 2013, p. 1). Most of the professional institutions in the construction industry, such as the Hong Kong Institute of Architects, Hong Kong Institution of Engineers, Hong Kong Institute of Surveyors, Hong Kong Institute of Facility Management etc., have also gradually set up BIM Committee or Task Force and organized Continuing Professional Development (CPD) events for BIM-related topics.

In 2011, the Hong Kong Institute of Facility Management (FM) organised the first BIM and FM conference with the title "The Way Forward for Facility Management: Building Information Modelling". In the flyer of the conference, it reads: "*...up to now, the use of BIM has focused mainly on the design and construction phases in the building process*" – indicating that BIM had been adopted in use but of limited extent at that stage.

While the developments of BIM usage have much been recognized by the statutory bodies and construction practitioners, etc., the reality is that after more than a decade's development, Hong Kong is still not yet in a position of "further development in BIM". As concluded by Zhang (2015), "*However, the implementation of BIM in practice has encountered obstacles. The adoption rate of BIM varies and BIM fails to meet the core expectation of reinforcing the inter-disciplinary collaborations*" (Zhang, 2015- Abstract p. 1).

Zhang's view could be reinforced by the following abstracts from the Roadmap for Building Information Modelling Strategic Implementation in Hong Kong's Construction Industry (Roadmap 2014), in which it says, "*While individual stakeholders are preparing for, or have prepared to use BIM, they wish to see a more organised and systematic approach that drives the industry-wide adoption of BIM in Hong Kong through the concerted efforts of the construction industry*" (Hong Kong SAR Construction Industry Council, 2014, p. 9).

Furthermore, based on the comparison of the "bimSCORE" in BIM implementation prepared by Dr Calvin Kam on BIM implementations as shown in the Roadmap 2014, Hong Kong situates in between "Typical practice" and "Advance practice" only, and are ranked much behind the "Leading Practice Countries", in particular the part on "Performance". The "bimSCORE" refers to the level achieved in BIM implementations in the construction industry, as shown in the figure below:

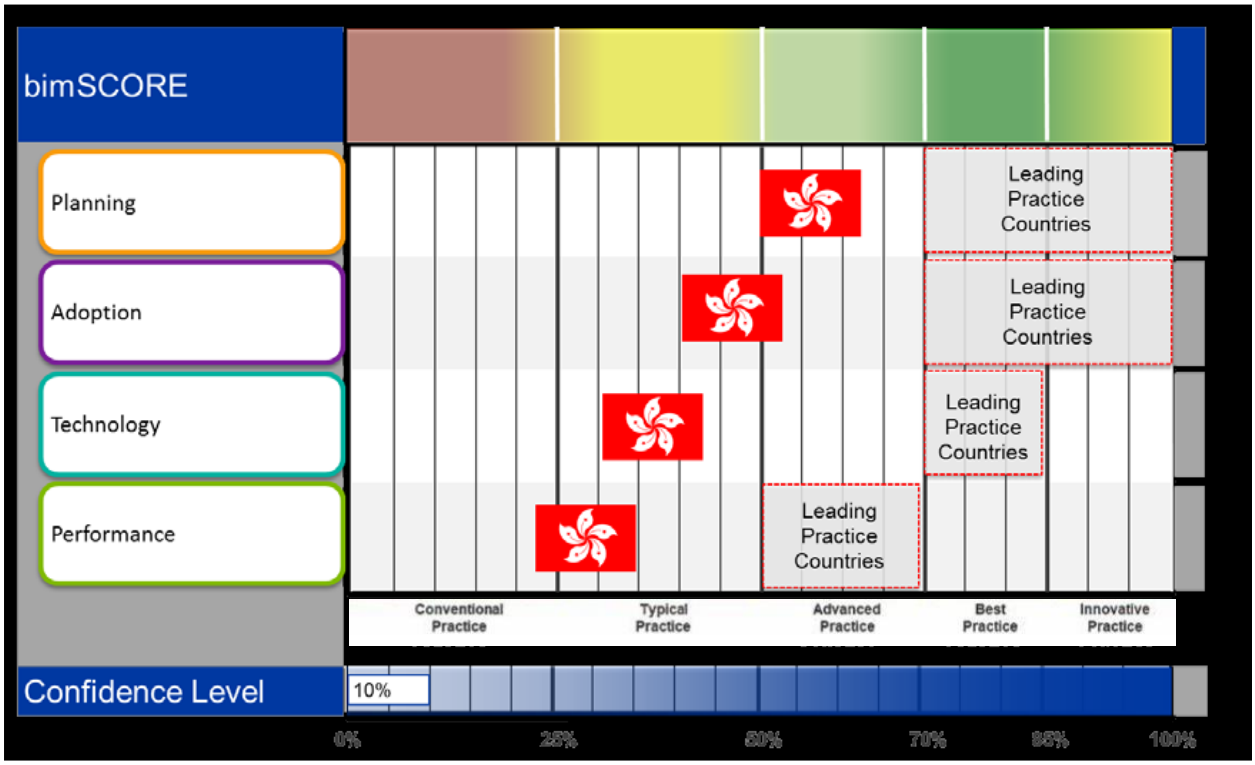


Figure 2-4 bimSCORE of BIM Implementations

Legend:  =Hong Kong

All the above could be summarised by two statements in the Roadmap 2014 (Hong Kong SAR Construction Industry Council, 2014):

1. "In Hong Kong's construction industry, BIM is at an early stage in the adoption process." (p. 8)
2. "Still there is scope for us *(Hong Kong)* to learn in the global marketplace." (p. 22)

Status updates

In 2018, Dr Calvin Kam conducted an updated assessment. It is found that while there have been improvements (except the one for Planning which has been dropped), still the scores are behind those in the leading countries (Kam, 2018). The summary of the updated bimSCORE of BIM implementations in Hong Kong in 2018 is shown at the figure below:

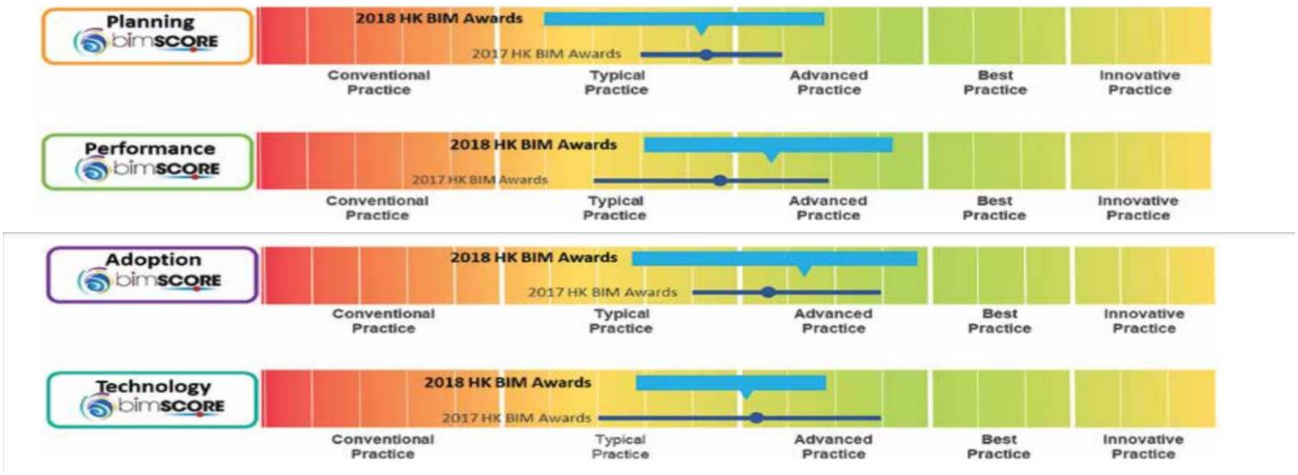


Figure 2-5 bimSCORE of BIM Implementations in Hong Kong 2018

Source: Advisors' comments in Autodesk Hong Kong BIM Awards 2018

Law and Lai (2018) also considered that the pace of getting BIM implemented on building projects has been sluggish (Law and Lai, 2018). As indicated from both the Chief Executive Policy Address (HKSAR Government, 2017a) and the Construction 2.0 (Development Bureau, 2018), by 2018 Hong Kong is still not yet in a "*fully BIM implemented*" status.

As a summary, the literature reviews above show that BIM usage Hong Kong is only at the early stage, and is much falling behind other leading countries, thus BIM implementation in Hong Kong is still in the "process".

2.3.7 BIM Benefits and Barriers

There are many papers advocating that the adoption of BIM would bring about benefits in terms of cost, time and quality. However, barriers or resistance on implementations are also identified in many cases. As pointed out by Hochscheid and Halin (2018), for "*any operation that generates benefits is also likely to produce negative effects*" (Hochscheid and Halin, 2018, p. 259).

The above implies that there are "positive" effects imposed by benefits, as well as "negative" ones being exerted by the barriers. The situations and combined effects of them could be summarised in the figure below:

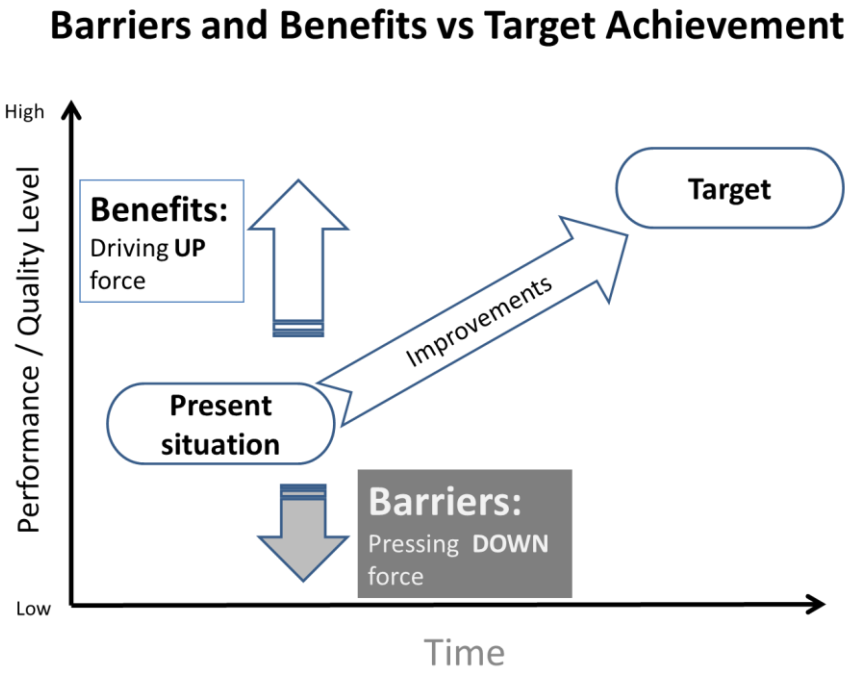


Figure 2-6 Barriers and Benefits vs Target Achievement

For improvement of performance or quality, some sort of upward driving forces must be there. In terms of BIM, the benefits that successful BIM implementations would provide could be considered as the upward driving force, pushing all parties involved to reach up to the target effectively and efficiently. However, in reality, there are also downward pressing forces, being imposed by the barriers or resistance in the implementations.

Obviously, if the driving up forces are greater that the pressing down ones, performance and quality at the targeted higher level could be achieved effectively within a short period. However, in the case that "*the barriers are greater than the government protagonists suggest*" (Garrigos and Kouider, 2016, p. 65), the pressing down force is greater, or even of the same magnitude, then the target could never be met. The question would be "Is this an answer to the slow pace of BIM implementation in Hong Kong?" If it is the case, what have happened, what should be done to improve the situation?

Literature reviews below would show that BIM implementation would lead to improvements to the construction industry as its implementation would result in much benefits in various aspects, and is an approach that could fulfil the demand for improvements. Below are summaries of the major benefits.

Benefits to owners

"Top BIM benefits perceived by owners include:

• BIM visualization to enable better understanding of the designs

• Fewer problems during construction from deficient documents or coordination

• More well-reasoned design due to BIM analysis and simulation

• Beneficial impact on the project schedule"

(Jones and Bernatein, 2014, p. 1)

Benefits to all stages

Eastman pointed out that the benefits would spread across all four stages as follows (Eastman, 2011):

- Preconstruction
  - Concept, feasibility, and design benefits
  - Increased building performance and quality
  - Improved collaboration using integrated project delivery
- Design Benefits
  - Earlier and more accurate visualization of a design
  - Automatic low-level corrections when changes are made to design
  - Generation of accurate and consistent 2D drawings at any stage of the design
  - Earlier collaboration of multiple design disciplines
- Construction and Fabrication Benefits
- Post Construction Benefits

Benefits in terms of cost, time and quality

Time, cost, quality are the essential elements for successful project implementations to be achieved by all the parties. They would therefore be included as part of the essential factors for inclusion in the framework. Below are the review findings on these aspects.

KU and Taiebat opined that BIM applications are being promptly embraced by the construction industry to reduce cost, time, and enhance quality as well as environmental sustainability (Ku and Taiebat, 2011).

The following table is a summary of concurring views of other authors or research results, categorized under time, cost and quality:

Major BIM Benefits and sources	Positive Effects on project		
	Time	Cost	Quality
BIM will reduce waste (materials, resources & cost) through improved designs and construction processes (Salman Azhar, 2011)		✓	✓
Clients in particular can achieve significant benefits on their construction projects by adopting BIM as a process and tool to guide their delivery process to higher quality and performance for a whole building life cycle follows (Eastman, 2011)			✓
BIM leads to reducing the total cost and time as a direct benefit (Love *et al.*, 2013)	✓	✓	
The collaboration among stakeholders will expand the client's organisational boundaries which may lead to increased performance of the project during different stages of the life cycle (Arayici, 2015)	✓	✓	✓
This new process of sharing information will provide some direct valuable benefits for the client, specifically full project understanding (Bryde, Broquetas and Volm, 2013)			✓

Table 2-2 Time Cost Quality Effects on Projects

BIM Benefits in figures

The above benefits are descriptive only. Benefits in figures as shown in the table below might illustrate the benefits in a clearer manner:

Major BIM Benefits and sources	Positive Effects on project		
	Time	Cost	Quality
It is considered that BIM will be benefiting the construction industry because it could: (Stanford University's Centre for Integrated Facilities Engineering highlighted main	provide up to 7% reduction in the project period; reduce time taken to generate a cost estimate up to 80%,	reduce the un-budget change up to 40%;	increase the cost estimation accuracy up to 3%; increase the contract's value up to 10%.

Major BIM Benefits and sources	Positive Effects on project		
	Time	Cost	Quality
benefit of BIM, cited in CRC Construction Innovation, 2007)			
Potential BIM benefits as listed in The Construction 2025 (HM Government, 2013) published in United Kingdom are:	lower costs by 33% - by reduction in the initial cost of construction and the whole life cost of built asset	deliver faster by 50%: by reduction in the overall time, from reception to completion, for new build and refurbished assets	50% lower emissions: by reducing greenhouse gas emissions in the built environment 50% improvement in exports: by reducing the trade gap between total exports and total imports for construction products and materials

Table 2-3 Time Cost Quality Effects in figures

Other benefits in terms of time, cost and quality covered in some other literatures are also abstracted below:

It is considered that BIM will benefit the construction industry because it could:

- reduce the un-budget change up to 40%,
- increase the cost estimation accuracy up to 3%,
- reduce time taken to generate a cost estimate up to 80%,
- increase the contract's value up to 10%
- and provide up to 7% reduction in the project period.

(Stanford University's Centre for Integrated Facilities Engineering highlighted main benefit of BIM (cited in CRC Construction Innovation, 2007)

As stated in the article on BIM adoption in USA, the Project Committee of National BIM Standard-United States (NBIMS-US) has drawn up a document that aims at improving and analyzing the whole construction chain using a standardized informative model. This document pointed out that with BIM, the following have been achieved:

- a 5% reduction of the final construction costs
- a 5% increase of speed for project completion
- a 25% increase of AEC (Architectural, Engineering and Construction) sector's productivity
- a 25% decrease of manpower use

Also, this document underlined how the AEC companies had obtained a remarkable increase of Return of Investment (ROI) due to the adoption of BIM and that therefore, BIM is considered an indispensable methodology for achieving innovation in the constructions processes.

(*BIM adoption in USA: the first country to implement BIM is now falling behind in infrastructure technology - BibLus*, 2019)

In UK, the potential BIM benefits are summarised in percentages in the Construction 2025 (HM Government, 2013) as below:

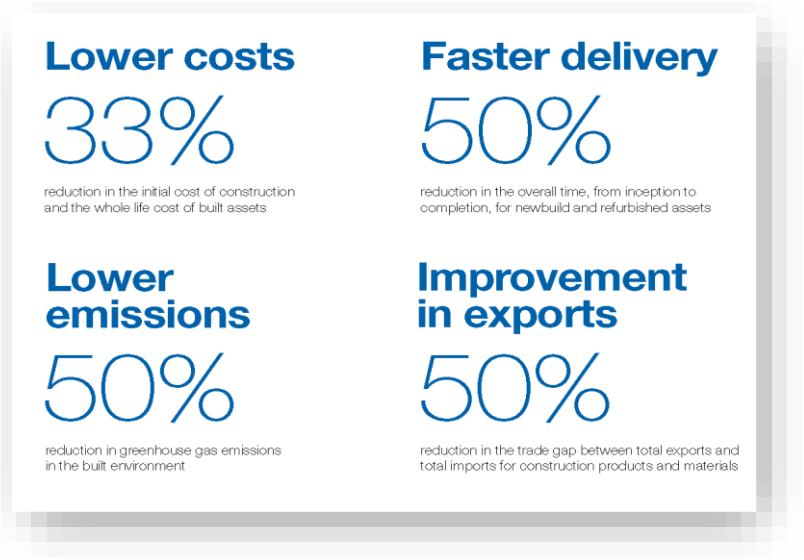


Figure 2-7 BIM Benefits (Construction 2025 (HM Government 2013))

As a supplement, the characteristic of the benefits could be further categorized according to time, cost and quality, another major factor on information flow also needs to be considered. As pointed out by Dakhil & Alshawi, the more accurate the information, the more effective the solutions will be. (Dakhil and Alshawi, 2014)

Information flow means communications between people. It would become useful when being used by "people". In this regard, the people aspect would also be an essential aspect in examining the benefits of BIM, and the same for barriers, and would also be covered in this study.

2.3.8 Barriers on implementation

It was advocated that BIM implementation is essential to the Architecture, Engineering, and Construction (AEC) industry of the United States. However, they also consider that the implementation of BIM lags far behind its potential due to the existence of various barriers (Liu *et al.*, 2015). A similar scenario is also located in the UK as they consider that the general industry consensus does seem to be that BIM is the future but "*the barriers are greater than the government protagonists suggest*" (Garrigos and Kouider, 2016, p. 65).

Chen et al (2017) is also of the view that BIM has been under aggressive promotion by governments throughout the world. However, they also pointed out that "*By contrast, the*

Architecture, Engineering, and Construction (AEC) industry shows reluctance to adopt BIM in its projects" (Chen K., Lu W., Peng Y., Zheng L., Niu Y., 2017, p. 1007).

For the Hong Kong construction industry, Ms Caroline Chan's view is that – "to foster BIM adoption in Hong Kong, the government should take an active role to demand the use of BIM from design stage in her projects" (Chan, 2014, p. 37). This would imply two indications:

(a) at that stage (year 2014), Hong Kong Government was not taking an active role;

(b) BIM adoption could be fostered if the Government takes the active role.

Since the Hong Kong SAR Government has taken the active role now by mandating the use of BIM for Government Projects and promote its use in private projects. Would this mean that all the barriers previously in existence have been or will be removed?

As a BIM practitioner, I would consider that most, if not all barriers would still exist. This view was also pointed out by Mr Francis Leung, one of the BIM pioneers in Hong Kong, in his presentation "BIM Practice by non-BIM Professionals" in the BIM Talks organized by the Hong Kong Construction Industry Council on 29 August, 2018.

2.3.9 BIM Adoption Pace

Based on the findings above, it would appear that there are substantial "upward" driving forces. However, the paces in adopting BIM by the industry are still not satisfactory. In Hong Kong, the reality is that after more than a decade's development, Hong Kong is still not yet in a position pending further development in BIM. As concluded by Zhang, "*However, the implementation of BIM in practice has encountered obstacles. The adoption rate of BIM varies and BIM fails to meet the core expectation of reinforcing the inter-disciplinary collaborations*" (Zhang, 2015- Abstract p. 1). The use of BIM in Hong Kong is therefore not catching up with the magnitude of the benefits.

Similar sluggish adoption pace is also found in UK. As pointed out by Mason, the reason is that "*the majority of companies are not BIM ready"* (Mason, 2016). After reviews of the research findings, it is found that the status has not been changed substantially even after the Government's mandate for BIM adoption.

2.3.10 BIM Adoption Issues

Why is BIM not well adopted to achieve the benefits? Why is the pace so slow even after the mandate? What are the obstacles encountered? While there are many multi-folded reasons behind the sluggishness, my view is that one of the major issues is that not all the parties involved are ready to adopt the changes for BIM implementation, and that they have not been equipped with the necessary guideline or framework to follow effective change implementation.

In fact, similar change journeys for accepting new technology in the construction industry did happen in the past. The latest and most relevant one is the change from hand drawings to the use of computer-aided-design (CAD). After the introduction of CAD in the 1980s, it has taken about 20 years for the construction industry to use this new revolutionary tool.

For this, I could still recall the bet in 1985 with a colleague when the first CAD computer station was installed in my office. The colleague, who had much experience in hand drawing but none in CAD, bet with me for a lunch that he could finish a A4 size floor layout plan before I could complete the start up the computer and the CAD software. Eventually he won! It was because of his relatively high efficiency in drawing when compared with the slow computer and software start-up processing at that time. This was served as one of the strong excuses, if not resistance, for not adopting to change to use CAD at that stage, mainly due to the comparative inefficiency of the hardware and software.

The same issue does happen when it comes to adopt BIM as comparatively the new authoring software would require longer time for start-up and more importantly, require much time to learn for using. However, I would consider that this is not the crucial issue. I would foresee that even after the efficiency of the hardware and software have achieved optimacy, there would be still barriers in adoption in BIM adoption. The rationales behind the information flow issues as mentioned early in Chapter 1 paragraph 1.4.1, and the "Affordability to change/not to change" covered in Chapter 5, paragraphs 5.7 and 5.8, would be issues faced in the BIM adoptions.

2.3.11 Resistances

Literature reviews have revealed that there are many articles, seminars, reports and books etc. covering various types of barriers and resistances faced/being faced by the industry. Such barriers would be imposing downward pressure forces hindering BIM implementation. Findings and summary of such from the reviews would be prepared with focus on the following:

- observations from seminars/conferences and preliminary review with practitioners indicating the existence of the resistance/barriers
- what would be the adverse effect on the success rate for implementation?
- could such adverse effect be alleviated, if not removed?
- actions being taken/ planned for improvement of the situations

Commentaries and summary to explain driving force behind the research project (but not yet the solution) are needed to further validate the values in conducting the research project, and the findings would then form part of the basis for further research to meet the objectives.

2.4 Change Models and Approaches

While time, cost, quality are the essential elements for successful projects completion, for effective change management, just aiming at these three factors only would not be adequate. There are many other wider, more complex but relevant issues that need to be taken into account. In this regard, review of literature concerning about changes have been conducted to acquire more in-depth understanding and knowledge in changes.

The following are reviews on factors under Cultural Knowledge Model, Force Field, Processes, Planned/ Organisation Development (OD) approach, Emergent Approach, Transdisciplinarity and

related approaches etc. Ultimately, the Change Management Framework would be established with these underpinning models and approaches.

2.4.1 The Culture Knowledge Model

As mentioned in Construction 2.0 (Development Bureau, 2018), there have been tough lessons, and out of the various factors for failures, "there is a 'human element' in construction projects that needs to be carefully considered in project planning" (p. 46).

In fact, it is quite easily understandable that human factor would be a significant one in the construction environment in Hong Kong, and also worldwide, because construction is a relatively labour-intensive industry. Literature review on such areas would also need to be reviewed.

As adopted by Dr David in his presentation in 2018 on "Context and Complexity" (Adams, 2018), the knowledge cultures identified by (Eadie *et al.*, 2014) could be categorised under the following five headings:

- Individual Knowledge
- Local Community Knowledge
- Specialised Knowledge
- Organizational Knowledge
- Holistic Knowledge

As illustrated in his presentation (Adams, 2018), these five different categories of knowledge could be summarised in a model as shown below:

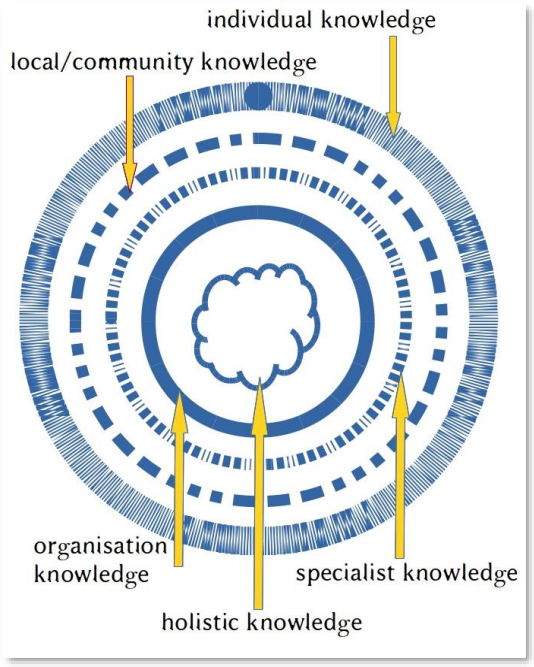


Figure 2-8 Knowledge Cultures adopted from Brown et al. 2010
(Brown, Harris and Russell, 2010)

Taking into consideration of the above knowledge sectors on cultural aspects, and after incorporation with the relative extent and nature of possible factors to be considered for BIM implementation, I would assert that the cultural factors that need to be dealt with during implementation could be categorized and presented in Figure 2-9 below:

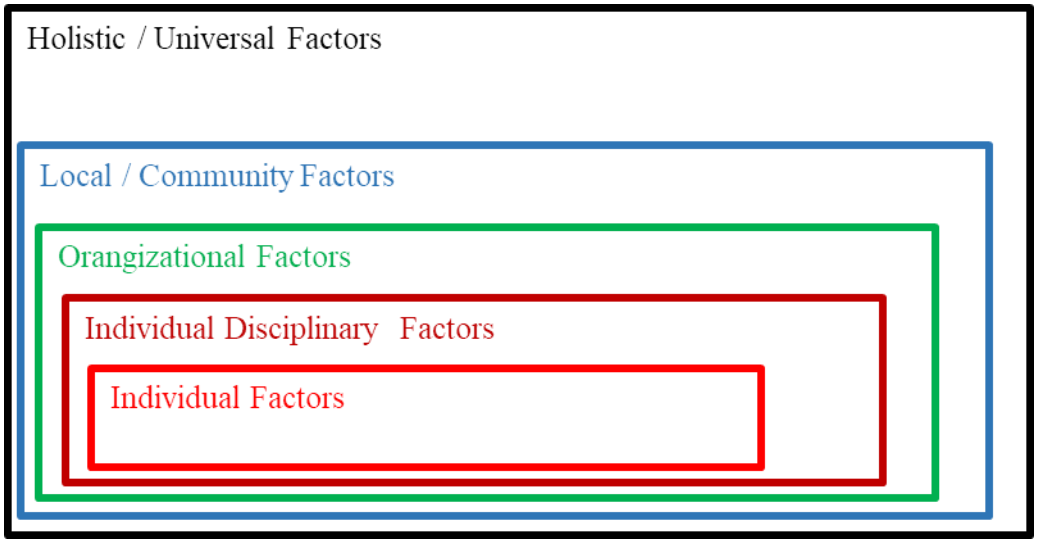


Figure 2-9 Cultural Factors Categories – In simple structure

As each of these factors would be having interrelationships with the others, sometimes within and sometimes beyond the purview of each individual subset, the reality might not be in such a simple structure and tidy manner as shown above but something messy like the one in complex structure as shown in Figure 2-10 below:

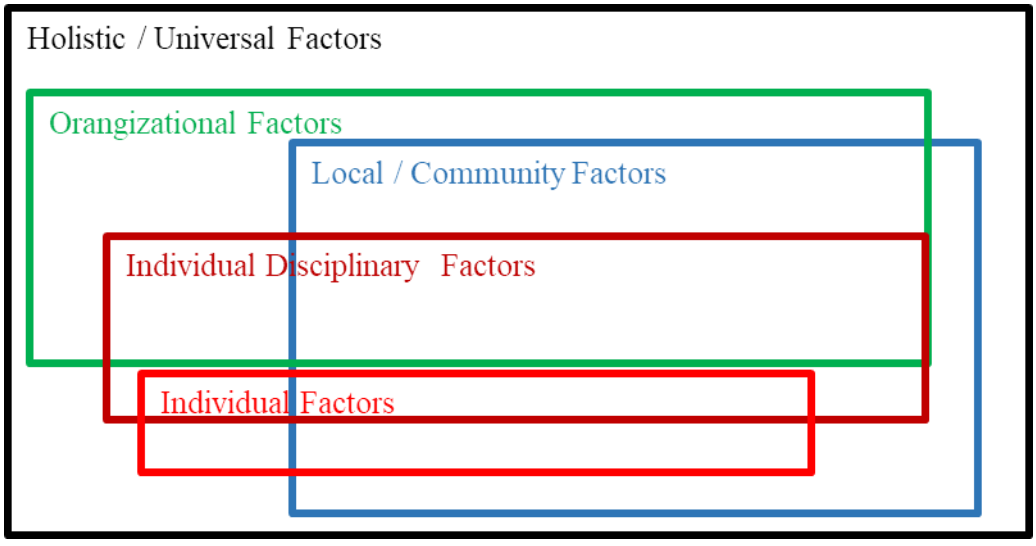


Figure 2-10 Cultural Factors Categories – In complex structure

With these categorizations or grouping of factors, it is anticipated that the possible large volume of varied cultural aspects (individual person, individual disciplines, organisation, local/community, and universal) with different factors and force magnitude etc. could be structured, enabling in-depth studies and analyses.

It can be ascertained that "things are not that simple" as mentioned and quoted in Dr David Adams' presentation, and as cited from Geertz (1973), the "*reality evidence a "multiplicity of complex, conceptual structures…knotted into one another, which are at once strange, irregular and inexplicit*". The concepts and theory behind this reality would need be considered and addressed properly in the project.

2.4.2 Reflection

In fact, as part of the objective of this research project, it is targeted to have the multiplicity and complexity of the factors be analysed so as to provide a framework that would look user-friendly, standardized and clear for the industry to make full use of it.

As a summary, study of Brown's Knowledge Culture has successfully broadened my knowledge in realizing and identifying the various types of knowledge and of cultural knowledge, thus hinting at the complexity of the factors to be addressed.

However, only cultural knowledge and factors themselves alone would not be sufficient because:

(a) not only cultural issues from the persons involved but many organisations would also be involved, and

(b) the fact that implementations would induce a lot of changes.

Furthermore, the changes would not be taken by individuals but many organisations in the industry as a whole, they would be of more complex nature requiring much wider considerations. This leads me to study other processes theories such as Change Process and Organisational Change Management further, with the objective of acquiring knowledge about the more complex ideas and the wider implications, impacts on communities and societal local and global issues as to explore if they would be applicable for being used in this research project, and the methodology.

From the assumptions above, I could see that the multiplicity and complexity would impose much difficulties in the analysis processes. Fortunately, as a practitioner with substantial work experience in the construction industry, I have clear understanding of the nature and characteristics of the factors, the rationales behind, the origins of the factors, the impacts and consequence effects, etc. Without such, effective analysis could not be conducted or could not get started even. However, I also understand that professional practical experience alone is still not adequate, in addition, thorough knowledge of the appropriate models and theories are also required. Further studies of such are therefore carried out in order to acquire such knowledge. The knowledge gained has equipped me to carry out the research successfully and eventually enabled me to complete the project works. Summaries of the studies of the models and theories are reported below.

2.4.3 Force Field Model

People involved in the construction industry facing BIM implementations might work individually for his/her own particular task, or as a group member with others to perform the same or shared tasks.

In this scenario, both the individual and team related factors would need to be considered. Lewin's focused conception of social change as summarised by Boje et al (2012) below would form a good reference on this aspect:

- "*Lewin's conception of social change has focused on two interdependent dimensions: the individual and the social system (more concretely, the small group).*" (Boje, Burnes and Hassard, 2012, p. 37). Firstly, Lewin dealt with the individual on theoretical grounds, and with the processes of change that the individual experiences with regard to acquisition of new information and values. After that, he formulated the theory of planned change, which has been expressed in terms of change of force fields.
- For individuals, "*Lewin used the term 're-education' to describe a process of change the involves more than merely acquiring new information, habits, and social skills*." (Boje, Burnes and Hassard, 2012, p. 37). Along this line, this theory would also be applicable for process changes acquiring new technology and technical skills. Although according to Lewin, "*re-education is a process of effecting change in self-perceptions and enabling individuals to overcome inner resistance"*, since "*behavior patterns are anchored in norms and interpersonal reactions originating in the groups to which one belongs or aspires to belong, successful re-education must include changes in one's own culture*." (Boje, Burnes and Hassard, 2012, p. 37).

Reflection/ comment: The above concept would work perfectly for social change. However, for the construction industry, since its nature resembles more like a business environment, and that the interest or objectives of individuals or individual groups would differ, application of such concept would need further refinement. In any case, this theory brings up one important issue: "re-education". For effective BIM implementation, providing merely "technology education" educating technological knowledge to the people involved would not be adequate. Instead, deeper inside re-educating to change the mind set or culture to adopt sharing and/or providing information with others would be required. Judging from my work experience and the heavy involvements in the promotion of advance technology and changes, I would comment that without such cultural/ social change, the blockage of information would still exist, which defeats the information flow improvements after BIM implementation. The Force Field Model concept, coupled with the Force Fields theories described in the following paragraphs, would form a good and essential foundation for implementing changes and have been adopted in use in the Change Management Framework (CMF) developed for this project.

2.4.4 Force Fields

Boje et. al (2012), quoted Lewin's views on Force Fields as follows:

" *… A planned change consists of supplanting the force field corresponding to the equilibrium at the begging level L1 by a force field having its equilibrium at the desired level L2. It should be*

emphasized that the total force field has to be changed at least in the area between L1 and L2" (Boje, Burnes and Hassard, 2012, p. 38).

In line with the above, Lewin's Force Field theory might be illustrated by the figure below by Lock (2017), with Level L1 referred to as the "*status quo*" and Level L2 as the "*desired state*":

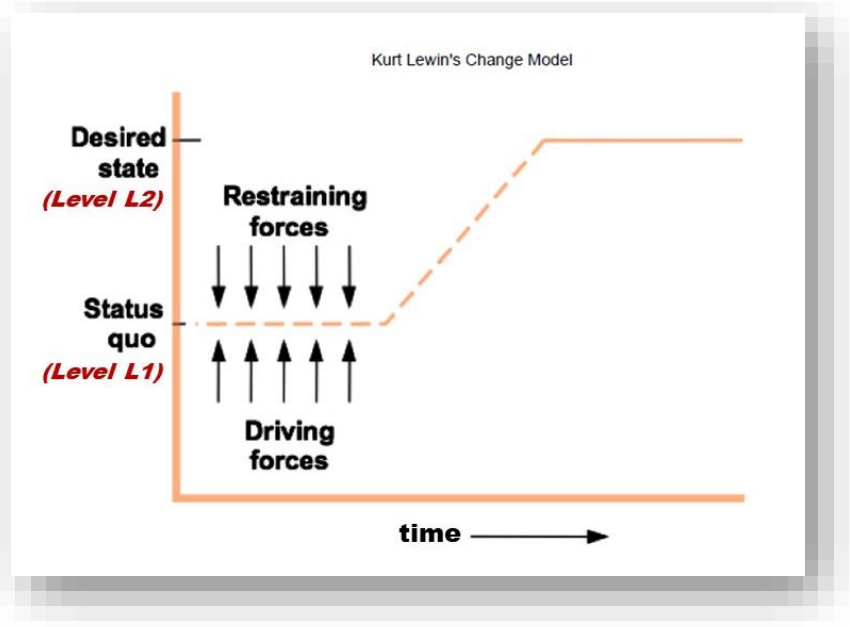


Figure 2-11 Lewis's Force Fields Model

As explained by Lock (2017), "*if an organization strives to keep equilibrium, it will work to maintain the balance. If on the other hand, an organization wants to create change, then it needs to unbalance or disrupt equilibrium*". (Lock, 2017, p. 2)

Generally, the change from L1 to L2 could be achieved by strengthening the driving forces (one of the balancing forces) in order to make these driving force stronger than the restraining forces (the other balancing force).

Reflection: The concept behind the Force Field Model indicates that for any targeted changes, there would be driving forces pushing for the changes, nevertheless, there would also be restraining forces that resisting the changes at the same time. In order to achieve or realise the changes, prior understanding of the detailed reasoning and sources of these two different types of driving forces would be required. Furthermore, the theory model or the graph above by Lock (2017), the magnitudes of these two driving forces and the possible "net" effected forces are not displayed, therefore they should also be studied. In response, the balancing forces and process theories described below would serve to supplement this aspect.

2.4.5 Balanced Forces

After quoting the observation of the former British prime minister Benjamin Disraeli (1804-81) that "change is constant", Senior (2020) advocated that along with this "accepted truism", it is important for organisations to strike a balance between both the forces for stability and forces for changes. For this, it is noted that the mandatory adoption of BIM uses should be considered as the "forces for changes", then the resistances, or retraining forces for not to adopt the use would also need to be well considered to strike a balance.

Reflection: The Newton's Third Law: Action & Reaction says: "*Whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first"*. From my work experience, it could be observed that this law is also applicable to "forces for changes". That is for any forces driving for changes, there would be "opposite forces", i.e. restraining forces for resisting changes. However, the opposite force might not always be equal to the driving force exerted but might even be bigger. The more important issue I have observed is that for some of the cases, the opposite forces are not there only to resist the driving forces but also to exerting forces upon other objects, causing them to resist the changes. As a result, careful consideration of these two kinds of forces would be necessary, otherwise, the rate in achieving the target would be slowed down due to the adverse effect of the opposite forces. In some occasions, the target could not be achieved at all because the opposite forces have successfully affected other factors, causing them to exert additional restraining forces to the changes. The Change Management Framework (CMF) developed in this project for BIM implementation has taken into consideration of these and is able to take into account the forces of different nature, magnitude of forces and effects and handle them in a well-balanced manner.

2.4.6 Re-education approach

As pointed out by Boje et. al (2012), "*in order for re-education to succeed, the group facilitator must create a strong "we feeling*". (p.38)

Boje et. al (2012), further quoted Lewin's views on the need for re-education as follows:

"*The establishment of this feeling that everybody is in the same boat, has gone through the same difficulties, and speaks the same language is stressed as one of the main conditions facilitating the re-education.*" (p. 37)

In line with this concept, it is important for all the people involved to have the same feeling to endorse the proposed change. For the construction industry, this would lead to considerable extent of changes because normally each party/organisation in the industry would be feeling very differently. One simple example is that the Employer, Consultants and Statutory bodies etc. are normally named as the "upper stream", while the contractors and suppliers would name themselves as the "downstream'. All the parties are on the same stream (although not the same boat), tasting different types of water due to various ranks. If the water in the stream is metaphorically interpreted as "power", those at the upper stream would have more of that. If water was the actual information, then those at the upper stream would be the providers with the discretion of providing it or not.

Reflection: Re-education, is therefore essential, not partially but globally for all parties. For each organisation or individual, this factor will be considered and included as part of their roadmap for

BIM implementation. On the global side, it would very much depend on the processes of implementation by the government and the industry as a whole. Both of these are covered under the categories of Strategy and External Propensity respectively in the Change Management Framework (CMF).

2.4.7 Process models of change

BIM is a kind of new process that imposes changes in the way the information is shared. In this aspect, criteria about the processes change would need to be well considered in the Change Management Framework.

After reviewing 20 different process theories, Hayes (2018) has summarized them into four processes namely:

- Teleological
- Dialectical
- Life Cycle and
- Evolutionary

(Hayes, 2018, p. 5)

According to Hayes (2018), each theory has its own assumption or focus. An abstract with the key words highlighted are as follows:

Teleological: changes are part of an **unfolding cycle** of goal formulation, implementation, evaluation and learning

Dialectical: changes are subject to the **balance** of the power between the opposing entities

Life Cycle: changes are processes that progress through a sequence of stages and that **each stage contributes to a piece** of the final outcome

Evolutionary: changes proceed through **a continuous cycle of variations**, selection and retention

Hayes (2018) pointed out that the "*common feature of all four theories is that they view change as involving a number of events, decisions and actions that are connected", "…but they differ in terms of the degree to which the present change…and the extent to which the direction of change is constructed or predetermined*." (Hayes, 2018, p. 5)

From the above, it could be observed that a change should not be viewed or proceeded as a single event but should be interpreted as stages and cycles. Variations to the change and dynamics would be found, and that there would be a "balance" or net change resulting from each of the stages/ cycle.

Hayes (2018) also pointed out "*those leading a change are less effective than they might be because they fail to recognize some of the dynamics that affect outcomes*…" (p.14). In this regard, "dynamics" should also be one of the major factors to be considered for effective change implementation.

Reflection: As mentioned earlier, the concepts behind these processes change theories do reinforce the "net driving force" presumption. In addition, the scholars also raised some more important items for consideration for establishing the change models: the "*variation*" and "*cycle*". For effective implementation of change, the possible variations, i.e., "change after change" or "change of change" would need to be well attended to, and that the change progresses would proceed in cycles but not as a one-off exercise.

While it is well understood that change implementation would not be a simple process, the reviews of theories above do further illustrate its complexity and the necessity for being managed properly for effectiveness. Coupled with the fact that BIM implementations would involve many individuals, groups, teams and organisations, understanding of theories on management of changes in organizational level are therefore necessary. Studies of these have been conducted and the findings are summarized in the following paragraphs.

2.5 Changes Theories

Before exploring applicability of change management theories on BIM implementation, a more in-depth review of the changes in BIM implementation are conducted first. This is because if there was no change imposed, then all change management theories would become irrelevant.

It could be observed from the adopted definition of BIM[#] as stated earlier that the implementation would involve several new items, namely "a *new tool* to holistically manage information", "a *new way* of working, using *new technology*". Obviously, changes to individual persons, i.e. the people, in adopting such new items would be constituted. Furthermore, since the use of such new items are involving "project management and execution", "process control", "cross-disciplinary collaboration", the changes do not merely effectuate on people, but also on the process in a cross-disciplinary manner. To conclude, changes would be imposed by BIM implementation and the change management framework should be able to cater for such.

(#The definition with the mentioned main items highlighted is given below for easy reference:

"BIM is not just a drawing tool but a *new tool* to holistically manage information relating to construction projects from planning stage, to design, construction and operational stages. It is *a new way of working*, using *new technology* to facilitate *project management and execution*, better construction *process control*, *cross-disciplinary* collaboration, internal coordination, problem solving, and risk management." *)*

2.5.1 Organisational Change Theory

Organisational change is considered to be relevant for BIM implementations in the context that the construction industry, as a whole, resemble the characteristics of an organization. As portrayed by Burnes (2017), "*organisations come in all shapes and sizes, provide a vast variety of products and services, and face an enormous array of challenges*" (Burnes, 2017, p. 392).

By applying this portraying approach, the construction industry could be described as "an entity involving with different companies/ teams/ individuals in all shapes and sizes, provide a variety of

products and services, and face an enormous array of challenges*"*. In fact, the construction industry consists of many different organisations, thus the changes or challenges imposed by BIM implementations would go face-to-face with the organizations involved.

2.5.2 Change of Changes Theory

In the summary of "How change has itself changed over the past 50 or 60 years of management research", Senior (2020) concluded that "*not only are there different types of changes, change also appears differently at different levels of an organisation*".(Senior, 2020, p. 72)

The same would also be applicable to the construction industry as the imposed changes from BIM implementation would vary at different levels within an individual organisation, and is perceived differently for different organisations in the construction industry as a whole.

The other two important concluding points, however, are:

(1) "*Planned change can lead to unintended outcomes that can lead to escalating positive or negative events*.", and

(2) "*Change also occurs as an unintended outcome of decisions elsewhere."* (Senior, 2020, p. 72)

With these two characteristics, organisational changes become more and more complex, always subject to change and unpredictable, falling in line with the quote below:

"All appears to change when we change" – Hernri Amiel

So, would the changes to organisation or those imposed by BIM implementations become unmanageable, and then the establishment of a change model would be infeasible? The reviews below would be able to provide a clue to answer these questions.

2.5.3 Change management theory

As quoted by Cummings et al (2016), Kurt Lewin is widely considered as the founding father of change management, with his unfreeze–change–refreeze or 'changing as three steps' (CATS) illustrated below:

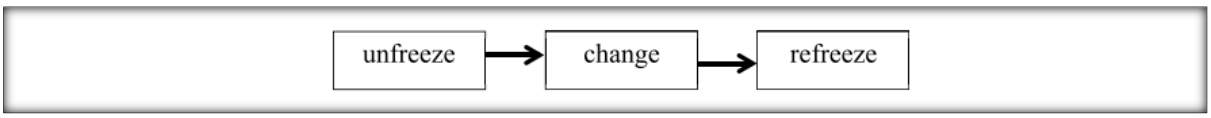


Figure 2-12 Change as three steps by Lewin

(Source: Cummings, Bridgman and Brown (2016) - p. 34)

While it is said that this 'changing as three steps' (CATS) "*has been criticized by scholars for over-simplifying the change process and has been defended by others against such charges*" (Cummings, Bridgman and Brown, 2016, p. 33), CATS is always regarded as the classic or

fundamental approach to managing change. A model further developed to form a seven-stage "Model of attitude change" which has been further developed and appended below.

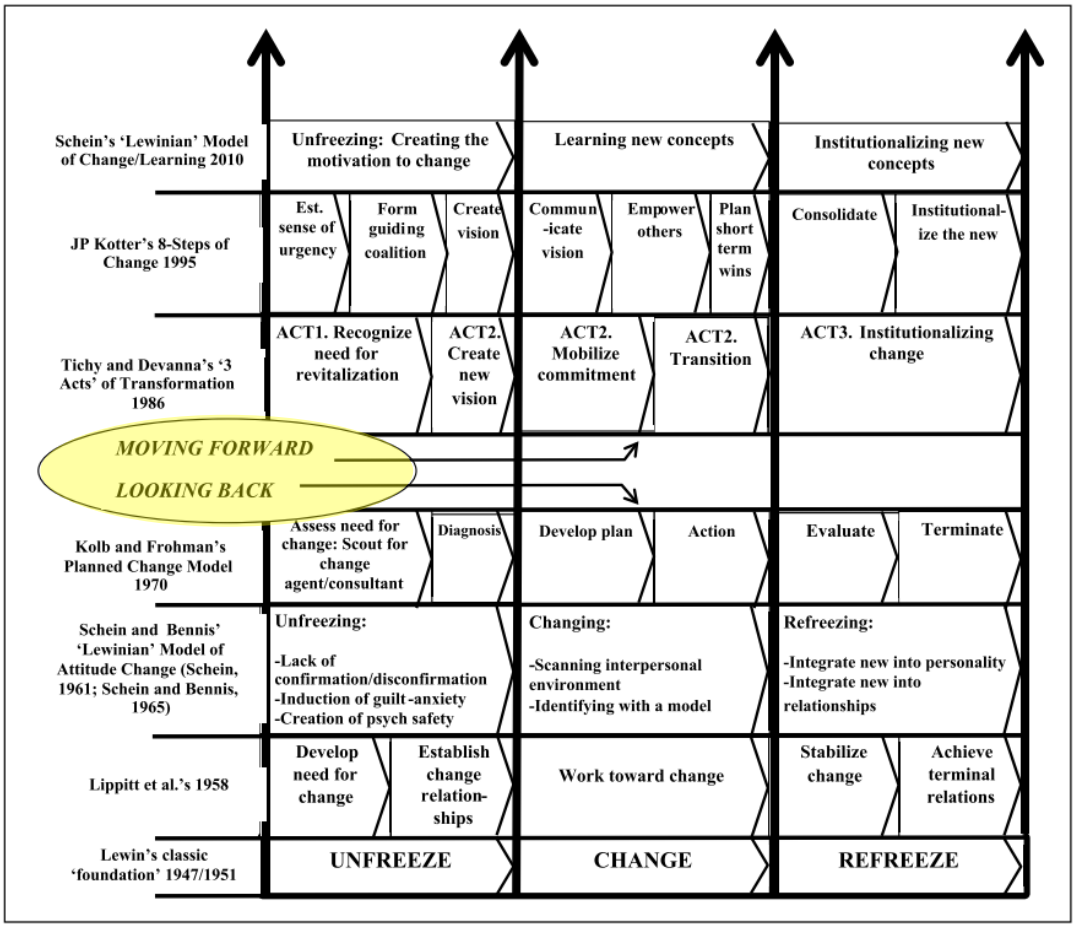


Figure 2-13 CATS as a grand foundation

(Source: Cummings, Bridgman and Brown (2016) - p.42)

The model above is described as a "*derivation of the change model developed by Lewin*" (Cummings, Bridgman and Brown, 2016, p. 46). From the model, it could be observed that the "moving forward and looking back" concept was introduced. However, what has not been shown in detail is the way as to how the "change in change" could be tackled, and how the reiterative processes should be carried out to achieve the targets.

It is noted that the aforementioned Force Theory and the Three-steps model, together with the other two elements, Group Dynamics and Action Research, formed the basis of the "Planned Change" or "Organisational Development" as developed by Lewin. The model is considered to be "*an iterative, cyclical, process involving diagnosis, action and evaluation, and further action and evaluation*" (Burnes, 2017, p. 346).

However, the model is also commented as "*an approach that recognises that once change has taken place, it must be self-sustaining (i.e. safe from regression)"* (Burnes, 2017, p. 346). In this regard, still the "change in change" in targets would not be well covered by this approach. This

would be the reason why Burns (2017) further commented that this approach is not suitable or not appropriate for a world with "unpredictable change", by saying the following:

"... for many years, the Planned/ Organisation Development (OD) approach was considered to be the best way of managing change. However, from early 1980s onwards, it faced a torrent of criticisms as to is suitability in a world of rapid and unpredictable change. In particular, its detractors claim that the notion that organisations operate in stable environments and can move from one fixed state to another is, to quote Kanter et al (1992:10), 'quaintly linear' and 'widely in appropriate'." (Burnes, 2017, p. 392)

Instead, to meet unpredicted changes, Burnes considered that the "emergent approach" would be more applicable and considered it to be the "best way to manage changes".

2.5.4 Emergent Approach Theory

"*The Emergent approach sees organizational change as an ongoing process of adoption to an unpredictable and ever-changing environment. For proponents of this view, change is a messy, unpredictable, open-ended and political affair. In such a situation, it is impossible for a few manages at the top of the organization to identify and implement all the change necessary to keep the organization aligned with its environment. Consequently, successful change is a bottom-up, emergent, response to events.*" (Burnes, 2017, pp. 392–393)

The above would explain the concept of the Emergent approach, For this approach, Burnes (2017) also advocated the following:

- "*The Emergent approach to change is based on the assumption that the environment in which organisations operate is changing rapidly, radically and unpredictably and will continue to do so*." (p. 384)
- similar to the Planned approach to change, the Emergent approach was also be criticized to be "*less a coherent approach to change and more a label for a collection of approaches critical of Planned change*." (p.393)

He suggested that a complexity-based Emergence appeared to be taking its place and explained how a framework for change could be constructed to identify the range of change situations and a matching range of approaches to change.

Reflection: After reviewing Burnes' framework, it is considered that while the coverage of the four major change elements, namely the behavioural, cultural, structures and processes changes are comprehensive and cover a wide scope, they are not suitable for being adopted as the basis for development of the change model for this research project.

On the other hand, the following main tenets of Emergent change as summarized by Burnes (2017) are considered to be more relevant to those for BIM implementation. Abstract of Burns' views are listed below:

- Organisational change is not a linear process or a one-off, isolated event.

- (The result) is best achieved through an interwoven pattern of (mainly) small- to medium-scale continuous changes which, over time, can lead to a major re-configuration and transformation of an organization.
- Change is a multi-level, cross-organisational process that unfold in an iterative and messy fashion over a period of years.
- Change is not an analytical-rational process.
- The role of managers is not to plan or implement change *per se*, but to shape the long-term process of change.
- … (managers) also have the prime responsibility for developing collective vision or common purpose that gives direction to their organization.
- The key organizational activities that show these elements to operate successfully are:
    - information gathering;
    - communication;
    - learning.

A detailed review of the above factors has been conducted. From the review, it is found that most of these factors are considered to be applicable to individual organizations or the construction industry as a whole and would play an important part in the change management framework. The following is a summary of the review on relevancy on changes imposed by implementation of Building Information Modelling.

Main tenets of Emergent change as summarized by Burnes (2017)	***Researcher views on relevancy on changes imposed by BIM implementation***
Organisational change is not a linear process or a one-off isolated event but is a continuous, open-ended, cumulative and unpredictable process of experimentations and adaption aimed at matching an organisation's resources and capabilities to the opportunities, constraint and demands of a dynamic and uncertain environment	For construction projects, there are many stages from early planning up to construction completion and then operations and maintenance. Changes imposed by BIM implementations would be different at each of the stages, not only on different parties with different interest, constraints or capabilities. Also, since it is a new type of technology and processes, uncertainties would inevitably exist.
This is best achieved through an interwoven pattern of (mainly) small- to medium-scale continuous changes which, over time, can lead to a major re-configuration and transformation of an organization.	While it is normally perceived that BIM usage is more appropriate for large development projects, in fact one of the major reluctances in adopting is the comparatively high risk of failure due to the uncertainties in use. Starting from small to medium-scale project would be

Main tenets of Emergent change as summarized by Burnes (2017)	*Researcher views on relevancy on changes imposed by BIM implementation*
	the better alternative but to reduce the risk level and thus the scale of resistances are essential.
Change is a multi-level, cross-organisational process that unfold in an iterative and messy fashion over a period of years and comprises a series of interlocking projects.	This ties in with the environment of the construction industry. As mentioned in the paper, there are many different parties involved in the construction industry, and that there is an "informal" leveling of upstream or downstream level amongst these parties. Their relationships are interlocking with involvements in the project works over years, and so would the changes.
Change is not an analytical-rational process. Instead, key change decisions evolve over time and are the outcome of political and cultural process in organisations.	Construction industry, being affected by the social, economic or political environments etc., would behave or evolve similarly.
The role of managers is not to plan or implement change *per se*, but to shape the long-term process of change by creating or fostering the organizational structure and climate which encourages and sustain experimentation, learning and risk-taking, and to develop a workforce that has freedom and motivation to take responsibility for identifying the need for change and implementing it.	For the construction industry as a whole, the Hong Kong SAR Government is acting in the role of manager as they mandate the BIM usage. Besides the mandatory requirements, some incentives such as financial support for buying equipment or technical training are provided. However, the part on provision of appropriate "freedom and motivation" is running short and probably may be one of the reasons for sluggishness in the implementation processes.
Although managers are expected to become facilitators rather than doers, they also have the prime responsibility for developing collective vision or common purpose that gives direction to their organization, and within which the appropriateness of any proposed change can be judged.	These have not yet been done by the Government, in the capacity of the managers in this aspect.

Main tenets of Emergent change as summarized by Burnes (2017)	*Researcher views on relevancy on changes imposed by BIM implementation*
The key organizational activities that show these elements to operate successfully are: • information gathering – about the external environment and the internal objectives and capabilities • communication – the transmission, analyses and discussion of information • learning – the ability to develop new skills individually and collectively, identify appropriate responses and draw knowledge from their own and others' past and present actions	All these would also be applicable for successful BIM implementation plans.

2.6 Transdisciplinarity and the Construction Industry

The construction industry obviously is not a single disciplinary but multi-disciplinary one, requiring various collaborations amongst different parties, such as the clients, design consultants, contractors, subcontractors, suppliers and services providers. For BIM, Succar therefore stated that it was not just a technology, but also a project management tool and process which consists of all aspects and disciplines with which all the stakeholders could collaborate more accurately and efficiently (Succar, 2009).

In the article for a transdisciplinarity research project on built-environment, Femenias and Thuander pointed out that besides technical issues, there are a lot of other externalities affecting the built-environment, or the construction industry. They said, "*we had the technical part ready but realized that this was the simple part of the challenge*" (Femenías and Thuvander, 2018, p. 1).

His research generalized from five projects revealed that "*different kinds of transdisciplinary research approaches co-exist and that these can serve different purposes and situations. In most cases, transdisciplinary projects lead to raised levels of awareness of the complexity of real-world problems among participating partners*" (Femenías and Thuvander, 2018, p. 1).

The result is in fact a matching scene for this research project as construction industry is a complex one, always facing with real-world problems among different parties with different disciplines. BIM implementation in the industry therefore would need to address such issues accordingly.

Definition of Terms and relevance

Based on the discussions by Petrie (1992), (Evans, 2014) summarised and explained the discussions on the various terms related to disciplinarity. Below is an abstract of these explanations and discussion on the relevance to the construction industry, BIM, and this research project.

2.6.1 Disciplinarity

Toulmin, 1972, as cited in Petrie (1992), said that a discipline would connotes a number of things, including: "*A specialization of knowledge within some sort of overriding unity of cognitive endeavor*" (Petrie, 1992, p. 303).

This view could be directly applied to describe how various parties are working in the construction industry: all the parties are working together for completion of the same target (the works project), and that each of them would have specialised knowledge in their own field, contributing their knowledge and skills for the works, and at the same time exerting interferences to each other when performing their own tasks.

2.6.2 Multidisciplinarity

Petrie (1992) described multidisciplinarity as "*the idea of a number of disciplines working together on a problem, an educational program, or a research study. The effect is additive rather than integrative. The project is usually short-lived, and there is seldom any long-term change in the ways in which the disciplinary participants in a multidisciplinary project view their own work*" (p. 303).

This would be partially applicable to the construction industry, in the sense that most of the "effect" is also usually short-lived, being effective mainly for the particular works project they are working with. However, there would still be some comparatively longer-term effect as the experience and knowledge would be affecting the other projects handled by these experienced parties. However, mostly such effects would still on individual disciplines only as the works project team might not be the same in the other projects. In other words, the construction industry is mainly operating on a project-by-project basis, and thus sharing of the knowledge newly acquired would be limited too. With this characteristic, the implementation of BIM might effectively serve as a common platform for sharing within members of an individual project. However, it would not be readily available for being used in sharing amongst different projects.

2.6.3 Interdisciplinarity

In his article posted under the web site of Purdue Polytechnic Institute, Evan (2014) explained that Interdisciplinarity was a result of "*moving to extend the idea of multidisciplinarity to include more integration, rather than just addition*". He quoted an example by Petrie (1992) to illustrate the term as below: "*Interdisciplinary subjects in university curricula such as physical chemistry or social psychology, which by now have, perhaps, themselves become disciplines, are good examples. A newer one might be the field of immunopharmocology, which combines the work of bacteriology, chemistry, physiology, and immunology".* (Evans, 2014)

BIM in the initial stage would be perceived as a new discipline because it is "a *new tool* to *holistically manage information*" and "a *new way of working, using new technology*" (Hong Kong SAR Construction Industry Council, 2014, p. 17), and would require a new and separate team for implementation. In its full implementation, BIM should be integrated and form part of the services provided by each of the disciplines. This separate team scenario would last for a considerable long period. Also, on the academic side, teaching for BIM would be established as a new subject.

For a "new" teaching subject, the example given by Petrie (1992) was "turning to the schools, there are a number of national efforts to turn the 'layer cake' (first biology, then topped by chemistry, then topped by physics) approach to American science education on its side. These efforts would require an interdisciplinary approach to teaching science since, at any given time, a combination of biology, chemistry, and physics would be studied. The various interconnections among these traditional disciplines would then need to be emphasized, and fundamental principles, including mathematics, could be taught and learnt more efficiently and effectively." (p. 304).

Similarly, teaching (and also implementation) of BIM would involve various interconnections amongst the traditional disciplines, such as urban planning, architectural, structural, building services design, quantity surveying, construction technology and management, maintenance and operation management etc. would need to be emphasized, and the fundamental principles could be taught (or implemented) more efficiently and effectively.

2.6.4 Transdisciplinarity

Evan (2014) also quotes the views of Petrie (1992) that "the notion of transdisciplinarity exemplifies one of the historically important driving forces in the area of interdisciplinarity, namely, the idea of the desirability of the integration of knowledge into some meaningful whole" (p. 2). And also, "transdisciplinary activities, to be sure, tend toward addressing questions of theoretical understanding, especially those of the unity of knowledge, but the distinction between theoretical concerns and practical questions in interdisciplinary work seems worth making". In this regard, it is indicated that while the "unity of knowledge" should be focused on, the other related concerns and practical issues should also be properly addressed too.

As a further review, the abstract of the quotations by King *et al* (2009) from leading writers on transdisciplinary, coupled with my supplementary notes on their relationship to this research project, are given below:

- Carpenter (2005) : "*Transdisciplinary models of practice aim to provide more family-centred, coordinated, and integrated services to meet the complex needs of children with disabilities and their families."* (King *et al.*, 2009, p. 211). -- BIM implementation should have a similar aim to provide more project-centred, coordinated, and integrated services to meet the complex needs of the parties and their counterparts in the construction industry.
- Carpenter, 2005; Davies, 2007: "*In contrast to other service delivery approaches, TA (transdisciplinary approach) is considered to reduce fragmentation in services, reduce the*

likelihood of conflicting and confusing reports and communications with families, and enhance service coordination." (King *et al.*, 2009, p. 211). – In fact, these reductions are also the targeted achievements for BIM implementation so as to enhance the coordination amongst all parties.

- Davies, 2007; Johnson et al., 1994 : "*Transdisciplinary service is defined as the sharing of roles across disciplinary boundaries so that communication, interaction, and cooperation are maximized among team members.*" (King *et al.*, 2009, p. 211). – similar to the above, such maximization would be also one of the BIM implantation objectives and benefits.
- Fewell, 1983; Peterson, 1987; United Cerebral Palsy National Collaborative Infant Project, 1976 : "*The transdisciplinary team is characterized by the commitment of its members to teach, learn, and work together to implement coordinated services"* and Davies, 2007; McGonigel, Woodruff, & Roszmann-Millican, 1994: "*A key outcome of TA (transdisciplinary approach) is the development of a mutual vision or "shared meaning" among the team*" (King *et al.*, 2009, pp. 211–212) – the BIM implementation team shall have such characteristics, members' commitment and targeted key outcome.

Reflection: From the above, it could be observed that different kinds of transdisciplinary and relevant research approaches co-exist and that they could be used as bases for review, analyses and applications by the parties involved in the construction industry, in particular, BIM implementations.

Summing up

The above literature reviews cover not only technological issues, but also examinations of the relatively more complex non-technological factors, such as ideas / theories/ approaches that might affect BIM implementation and the changes to be managed. For this project, as a kick-off of the secondary research stage, the literature review findings above would be used as the base for categorizing the factors, with the objective to furnish a list of the major factors being considered as benefit or barriers.

For the primary research, the factors identified within the literature reviews would be reviewed, analysed and compiled with more details for being included in the review and analysis. The findings would be used as the basis for establishment of the change management framework. Details of such would be covered in Chapter 4 and Chapter 5.

According to Maguire, "*Transdisciplinarity concerns that which is at once between the disciplines, across the different disciplines, and beyond all disciplines. Its goal is the understanding of the present world, of which one of the imperatives is the unity of knowledge*" (Maguire, 2018, p. 106). The change management framework, being established for this research project after taking into account of the reviews findings above, could be described similarly as follows: "The framework would be between the disciplines, across the different disciplines, and as a contribution, beyond all disciplines in the construction industry."

2.7 The need for proper BIM implementation

When properly implemented, BIM can provide many benefits to a project. The value of BIM has been illustrated through well planned projects which have yielded increased design quality through effective analysis cycles, greater prefabrication due to predictable field conditions, improved field efficiency by visualizing the planned construction schedule, increased innovation through the use of digital design applications, and many more. At the end of the construction phase, valuable information can be used by the facility operator for asset management, space planning, and maintenance scheduling to improve the overall performance of the facility or a portfolio of facilities. Yet, there are also examples of projects of which the team did not effectively plan the implementation of BIM and incurred increased costs for the modelling services, schedule delays due to missing information, and little to no added value.

Implementing BIM, therefore, requires detailed planning and fundamental process modifications for the project team members to successfully achieve the value from the available model information (The Computer intergrated Construction Research Group, 2011).

2.8 Data Collection and Analysis

2.8.1 Essential elements for successful project implementations

Time, cost, quality are the essential elements for successful project implementations and are the "well-understood" targets (if not only the "terms") to be achieved by all the parties. They would therefore inevitably be included as part of the essential factors for inclusion in the framework. As a start, at the secondary research stage, the above would be used as the basis for categorizing the benefits, with the objective to furnish a list of the major factors being considered as benefit or barriers on the grounds of the literature review findings.

For the primary research, the factors identified from the literature reviews would be reviewed, analysed and compiled with more details for being included in the review and analysis. In order to enable revealing of the impact differences amongst each of the factors, i.e. the magnitude of the forces imposed, a symmetric scale with the objective to capture the intensity of the respondents' perceived impact strength for each of the factors would be required.

2.8.2 Scaling of data and Likert Scales

According to the research findings by Chomeya (2010), there are a lot of measurement forms or tests and can be divided into several kinds of self-report. In his paper, it is concluded that "*the measurement of personal attributes especially the internal attributes which can be measured easily, conveniently, quickly and give the certain and constant results usually use the measurement form or the test of Rating Scale (Wright and Masters, 1982) especially the measurement of attitude, opinion level, satisfaction, motivation, self-discipline, self-efficacy.*" (Chomeya, 2010, p. 399).

In the same paper, it is also established that "*this kind of measurement has a lot of aspects but the popular one is Renis Likert rating scale (Aiken, 2000; Cohen and Swerdlik, 2001; Gregory, 2003)",* and that its advantages are *" (1) the consideration criteria is certain and easy to use and (2) The questions are not too many but give higher reliability than other rating scale types (Snaw and Wright, 1967)*" (Chomeya, 2010, p. 399).

Garland (1991) viewed that "*the purpose of a rating scale is to allow respondents to express both the direction and strength of their opinion about a topic."* and commented that Likert Scales are *"widely used in market research and have been extensively tested in both the marketing and social science literature*" (Garland, 1991, pp. 66–67). Also, as pointed out by Boone and Boone (2012), the Likert Scale is developed in response to the difficulty of measuring character and personality traits for measuring attitudinal scales (Boone and Boone, 2012).

According to Sullivan and Artino (2014), the Likert Scale is developed to "*measure attitudes, with a 5- or 7-point ordinal scale used by respondents to rate the degree to which they agree or disagree with a statement*" (p. 541). Also, they pointed out the following:

- with such an ordinal scale, responses could be rated or ranked but the distance between responses is not measurable;
- experts over the years had argued that the median should be used as the measure of central tendency for Likert scale data;
- other experts asserted that parametric tests could be used alongside with the Likert scale ordinal data if there is an adequate sample size and if the data are normally distributed (or nearly normal).

Having said the above, for measuring "*less concrete concepts, such as trainee motivation, patient satisfaction, and physician confidence*" (p. 542), they recommended that the common practice of educators and researchers in creating several Likert-type items, grouping them into a survey scale, and then calculate a total score or mean score for the scale items could be adopted (Sullivan and Artino, 2014).

In line with their recommendation, means would be used to describe the data if it follows a classic normal distribution, or otherwise frequency distributions of the responses will be reported for more meaningful descriptions. Furthermore, should the analysis of the collected data reveal the necessity, appropriate tests (such as parametric tests etc.) would be used to further analyze the scaled responses.

In view of the above, and the fact that mainly the perceived impacts of less concrete nature would be measured, it is considered that Likert scales with ordinal responses would serve the objective to be achieved in the survey and would be adopted for use in this research project.

2.9 Reflection

From the literature reviews, I found that apart from the benefits of adopting Building Information Modelling (BIM), there are also many articles, seminars, reports and books etc. which cover various types of barriers and resistances faced/ being faced by the industry for BIM implementation causing sluggishness in the implementations. In fact, similar sluggish change journeys for acceptance of new technology in the construction industry did happen in the past. Thorough studies of the factors behind are essential for exploring means of improvements. Since human capital is one of the major elements in any change implementation, relevant cultural knowledge and factors are also important and therefore have also been studied. In view of the fact that changes for BIM implementations would not be taken by individuals, but by many organisations in the industry as

a whole, studies of other processes theories such as Change Approach, Force Field, Change Process and Organisational Change Management, etc., have also been studied in order to acquire knowledge in the more complex ideas and the wider implications, impacts on communities and societal local and global issues.

All the above have much enriched my theoretical knowledge for further pursuing the research project works. With all such enriched knowledge, coupled with my existing knowledge and experience, I found myself in a much better and equipped position to carry out the research, and to develop the research methodology to be reported in the next Chapter.

Chapter 3 Methodology

This chapter discusses the research methodology adopted, with an outline of the rationales behind, the complexity nature of the project involved, the approaches used for information collection and analysis. The chapter ends with details of ethical considerations of the research, with particular considerations in light of the project nature and recent conditions.

3.1 Research Methodology

As discussed in Chapter 1, I would be taking the role as an insider-researcher for this research project, implying my role in researching and developing aspects of my work practices and being a change agent in my professional community. In the research project, I would be involved more in the capacity of a detached observer, so as to provide unbiased observation and recommendation, rather than an interested participant alone. This will mean that I am portraying myself in the research and demonstrating, rather than hiding, my influence upon what I am reporting.

It is said that "*complexity is a key characteristic of construction projects. It is the degree of complexity that determines the overall approach to a project, specifically the required resources as well as tools and techniques*" (Brockmann and Kähkönen, 2012, p. 716). Complication is also the other characteristic as it would involve many kinds of processes, people, workplace, working together with different objectives, different disciplines, different technology etc. but not necessary at the same stages throughout the asset life cycle. As for Building Information Modelling (BIM), its extent and coverage cover all these involved aspects, it has also inherited the complexity and complicated character.

A "Mixed Approach" applying to both "Qualitative" and "Quantitative" types of research would therefore be more appropriate to be used in this research project so as to from a comprehensive and holistic review of the existing knowledge, supplemented with expertise's views, advice and recommendations in the practical field (qualitative). The findings are then further reviewed by a larger group of subjects to obtain feedbacks, followed with analysis to reveal the validity of the findings (quantitative).

3.2 Secondary Research

The secondary research would be done by thorough literature review aiming to master existing published or presented knowledge on the subject matter Benefits and Barriers of BIM implementation. The coverage would not be confined to published books, journals or articles but also notes of presentation in seminar/ conference, organisation/ institutions' mission and business objectives etc. While close attention would be paid to those related to the local context of Hong Kong, as in future, the framework to be established would be used locally, at this stage, those globally in the worldwide would also be examined to form a comprehensive review.

3.3 Primary Research

Originally the intended approach is to summarize the above findings and forward such to seniors who have major influence on the implementation process for their perusal and then follow with

interviews with the objective to obtain their comment/views on these concluded findings and seek advice on additional factors/issues that need to be considered. However, after due consideration and the adverse effect imposed by COVID19, the approach inevitably has to be changed. Details of the revised approach and justifications are covered in Chapter 4 and below are the considerations that have been taken for formulating the research approach and the planned processes involved.

3.4 Applicability of the Adopted Research Approach

In order to form a comprehensive and holistic review of the complex and complicated issues, merely only a qualitative or quantitative type of research would not be sufficient. A "Mixed Approach" applying both of them would be required. I am in the position to adopt this choice of research approach as I have extensive experience, in particular, BIM implementations in the construction industry, or otherwise it would not be feasible.

In the secondary research, I need to analyse the findings from the literature reviews and transform them into meaningful and useful information. The review and analysis would require thorough understanding of the context or otherwise the results would not be informative or useful for further use in the primary research. Upon further reviews and analysis of these findings, I would incorporate the findings in the interview questions in order to obtain advice from practitioners on factors/issues that need to be considered based on their own judgment. I would be able to adopt this approach as my engagements in the construction industry and contributions have enabled me to conduct high quality interviews and involve experts from the appropriate fields and levels. Without such, the outcomes of the interviews would not be significant or with positive influence upon the industry.

Upon completion of the interviews, analyses of the transcripts based on the "Change Factor Analysis" developed (details in Chapter 4, paragraphs 4.4 and 4.5) are conducted. Similar analyses on visions and missions of relevant parties in order to reveal the current level of their commitments to Building Information Modelling (BIM) implementations are also done. Meaningful outcomes of such analysis could only be realised by researchers who have in-depth knowledge and understanding of the business objectives, strategies and policies establishments of organisations in the construction industry. Details of the processes are described in paragraph 4.6 of Chapter 4, and the ways these findings are interpreted and considered in establishment of the Change Management Framework (CMF) are covered in Chapter 5 paragraphs 5.1 to 5.8.

Upon completion of these analyses, the findings from the analysis are presented in written form. Collectively, they would be classified as findings from qualitative research. The project activity, however, could not be further pursued with only these qualitative research results.

To turn these research results into useful results to be incorporated in the Change Management Framework (CMF), they need to be reviewed and quantified into numeric format. The quantification processes are described in Chapter 4, paragraphs 4.11.6 to 4.12.7. Detailed descriptions of the applications of such quantified findings are covered in Chapter 5, paragraphs 5.9 and 5.10.

3.5 Analysis of Findings from Secondary and Primary Qualitative Research

The findings from the secondary research and primary qualitative research are treated as data, providing the foundation for review. They are then analysed and transformed into meaningful and useful information.

As mentioned above, "complexity is a key characteristic of construction projects" (Brockmann and Kähkönen, 2012, p. 716). Since the subject matter of the research project is BIM adoption in construction projects, the nature of the data collected would also be of a complex nature. The following flowchart, having simplified to a great extent, would indicate the complexity of the various stages and BIM users (participants) that would be involved:

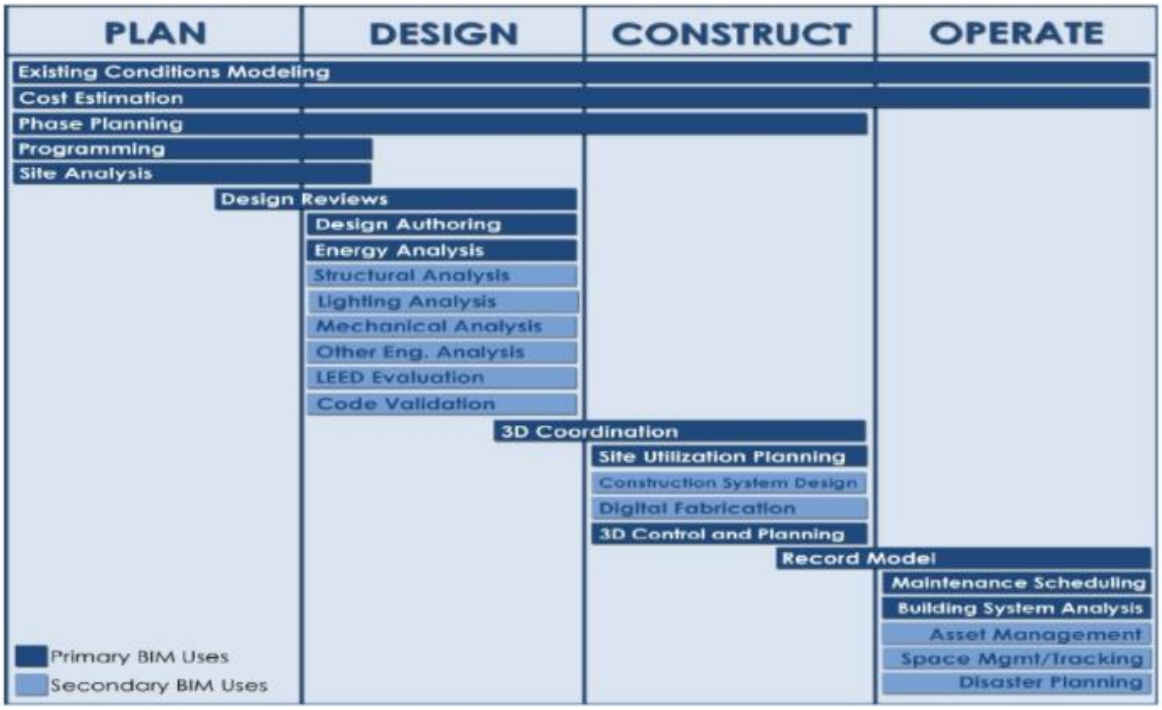


Figure 3-1 BIM Uses throughout a Building Lifecycle

Source: Project Execution Planning Guide version 2.1
(The Pennsylvania State University, 2011)

The diverse nature of people involved would likely be translated into the research data – making them varied, complicated, multidimensional and multi-folded, without any clear and straight forward pattern indication.

To cater for this observation, out of the various analysis methods, the approach used in thematic analysis is considered to be appropriate for being conducted because "through its theoretical freedom, thematic analysis provides a flexible and useful research tool, which can potentially provide a rich and detailed, yet complex, account of data" (Braun and Clarke, 2006, p. 78). However, it is the major components of the approach in thematic analysis that has been adopted, while its objective in finding the patterns has not been adhered to entirely. Detailed elaborations on the actual procedures adopted are covered in Chapter 4 Project Activity.

3.6 Analysis Process Framework

As pointed out by Maguire and Delahunt, there are many different ways to approach thematic analysis. It is suggested that 6-step framework proposed by Braun & Clarke (2006) would offer a clear and feasible framework for doing thematic analysis and thus was "arguably the most influential approach" (Maguire and Delahunt, 2017, p. 3353). In this regard, the framework as appended below would be used as the basis for the analysis.

Table 1 Phases of thematic analysis

Phase	Description of the process
1. Familiarizing yourself with your data:	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes:	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes:	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes:	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
5. Defining and naming themes:	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report:	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

Figure 3-2 Phases of Thematic Analysis

Source: Braun and Clarke (2006) (p. 87)

3.7 Thematic Analysis Methods

With the aid of thematic analysis, the important aspects about the complex data could be identified so as to represent some levels of patterned response or meaning.

The two major categories of thematic analysis method which have been reviewed are listed as follows:

- an essentialist or realist method: this method would report experiences, meanings and the reality of participants
- a constructionist method: for examining the ways in which events, realities, meanings, experiences and so on are the effects of a range of discourses operating within the society.

For this particular research project, report outcomes from both of these two analyses are considered to be appropriate. As suggested by Braun and Clarke (2006), a 'contextualist' method, sitting between the two ends of the spectrum, could also be adopted for thematic analysis. Since this "in-between" type of method would enable the provision of desired outcomes, it would be adopted for this research project.

3.8 Theme Identification Approach

Out of the two primary ways for identifying the themes, the 'theoretical' thematic analysis is considered to be more appropriate as it tends to be driven by the researcher's theoretical and/or analytic interest in the area and is thus more explicitly analyst driven. On the other hand, the themes identified by the inductive analysis would be strongly linked to the data themselves. They would mainly be data-driven only, thus my epistemological commitments would not be addressed and my intended knowledge contributions to the industry could not be achieved.

Upon completion of the thematic analysis, it is anticipated that a rich thematic description of the data set could be provided to enable readers to have a thorough understanding of the predominant and important themes about the factors to be considered in BIM implementation. However, even completion of such, the intended research objective has not yet been served in full. This is because even with such identified themes, not much could be done in terms of practical applications.

For this, as raised in Braun and Clarke's paper, the themes established might not be the most prevalent themes across the data set because the themes identified might only appear in between the data set only. Quantifiable measures have not yet been taken into account and the essence of such themes would not be well identified. Therefore, further quantified measurement of the prevalence of the themes would be required.

For this research project, similar procedures resembling the above would be used in the Change Factor Analysis. The procedures are found to be similar, because in order to cope with the particular needs of this research project, not all the procedures adopted are identical to those in the thematic analysis. The major difference is that for Change Factor Analysis, the target is to list as many factors as possible that need to be considered for change implementation, but not to attempt to identify the pattern exists behind the factors. Details of the reasons behind and adopted approaches of the analysis are covered in Chapter 4.

3.9 Adoption of Case Study as Further in-depth Research

In line with the "Form of Research Question" as stated by Yin (2018), the "what" questions, either of exploratory nature or about prevalence, would be covered in the research methods above (Yin 2018). However, the "how" and "why" questions would still need to be addressed. As suggested by Yin, case studies would serve to cover these two outstanding questions.

As an original attempt to reveal how the change management framework could contribute to effective BIM implementation, there would be test runs with organisations experimenting implementation as to obtain more background information for further review or enhancement of the framework. After studying the case studies, it is anticipated that more influencing factors regarding the change would be explored and this would further enhance the framework for use by the construction industry.

Since construction projects would normally span over four to five years, it might not be able to have the test run be conducted for all the stages for a new project. In this regard, the case study might be conducted at some selected stages only. Should deficiency in the proposed framework be found, they would be identified and then be analysed so as to reveal the reasons behind. The goal

of the study results not only discover generalizable truths or make predictions but also explore and provide further information for future research or application of the framework in other cases.

3.10 Researcher's capability

3.10.1 Insider Researcher

As mentioned earlier, for this research project, I would act as an insider-researcher. I would be in a position to do the research project in line with the aforementioned approach because I would not be involved in any of the actual works of the construction projects to be implemented with BIM. I would not be subject to pressure of getting the work done or responding to practical problems and would be able to maintain the research focus without any temptation to cut corners.

"*As an insider, you are in a unique position to study a particular issue in depth and with special knowledge about that issue*" (Costley, Elliott and Gibbs, 2010, p. 3). For this, as reported in my DPS 4520 paper, being a practitioner with substantial experience at senior level, and a professional with contributions and involvements in the professional institutions, achievements and recognitions in the construction industry, I would have the capability, appropriate status in the construction industry and the authority to provide advice, recommendations for implementing change for improvements.

Compliance of the following criteria of an insider researcher as indicated in the paragraph under "What makes an insider-led work based project?" (Costley, Elliott and Gibbs, 2010, p. 3), would serve to ***demonstrate*** my capabilities:

1. "Not only do you have your own insider knowledge, but also easy access to people and information that can further enhance that knowledge."

Prior to undertaking research for this project, I have been deeply involved in the quantity surveying, facility management and BIM sector of the construction industry. My contributions to the industry have been carried out with people who are academics, committee members of professional institutions and practitioners etc. from various government or commercial organisations, etc., who do not have any commercial interest in the projects. I have therefore established a platform for true heart sharing of views, enabling me and each of them to understand the underlying problems being faced by each other, the constraints and difficulties being imposed etc. by different disciplines, at different levels at different stages.

With this wide and close relationship network, my capability in accessing key people information and obtaining support that could further enhance the knowledge is ensured.

2. "You are in a prime position to investigate and make changes to a practice situation." "You can challenge the status quo from an informed perspective. This is vital when exploring a problem or issue in a detailed and thorough way."

I am a professional member of several professional bodies, have served (and would continue to serve) them as President or executive committee members in the coming years (for details please refer the list in Appendix 2 : *List of candidate's professional qualifications, major committee/ office holdings, contributions and presentations*). With these capacities and standings, I would be in a good position with influence capability to investigate and make changes to the industry through

the professional institutions to the practices. Coupled with my previous contributions, the network with practitioners and academics, I would also have the necessary network in accessing appropriate parties and disseminate the change recommendations.

3. "You have an advantage when dealing with the complexity of work situations because you have in-depth knowledge in many of the complex issues."

In the Pathway issued by the Royal Institution of Chartered Surveyors in 2018, it is stated that "*quantity surveyors work in all sectors of the construction industry worldwide. In real estate, this covers residential, commercial, industrial, leisure, agricultural and retail facilities..."* and *"They must understand all aspects of construction over the whole life of a building or facility. They must have the ability to manage cost effectively, equating quality and value with individual client needs…"* (RICS, 2018, p. 6)

My academic background is quantity surveying and therefore have been trained for meeting the above requirements, and to deal with complicated details and in particular study, analyze and transform information from drawings, specifications and/or other media from various parties and provide documents for use by various parties in the industry.

My work experience in the last 40 years, in both consultant and client organisations, have equipped me with extensive and in-depth knowledge of the construction processes and requirements in an all-round manner. In terms of asset life cycles, my services provided covering from early planning stage, detailed design, procurement, contracts management, construction, up to operation and maintenance and disposal of built assets.

With the above, both the adequacy of my knowledge and capacity in investigating and making changes, meeting the insider researcher requirements, are reassured.

3.10.2 Reflection

My contributions to the industry as mentioned under item 1 above regarding "***easy access to*** my contributions to the industry as mentioned under item 1 above regarding "***easy access to people"*** have enabled me to set up the list of interviewees for the primary research. The network I have could provide me a wide range of interviewee alternatives, all being experts in the construction field and have much influence on BIM implementation process. As an attempt to achieve quality of responses as well as comprehensiveness, I have to strike a balance and deliberate that ten or more interviewees should be invited to the interviews. After careful reviews of the various sectors and disciplines of people involved in the BIM implementations, eventually I have set up a list of 12 interviewees from six major sectors, each with two interviewees with different responsibilities.

The above preparation has formulated a successful high-quality interview list which enabled me to obtain the desired interview feedback. It has also reinforced my confidence to act as an insider researcher to carry out the research work. Besides, the feedback from the interviews has further encouraged me, or reinforced my confidence in carrying out the research work. Details of the setting up of interviewees list, the interview findings and the encouragements, etc. are covered in Chapter 4, paragraphs 4.9 and 4.11.

3.10.3 Ethical Considerations

It is said that construction projects could be considered to be "*the application by people of technology developed by people to achieve goals established by people involving the erection or retrofitting of infrastructure and buildings. …*" (Toole, 2006, p. 300). In this regard, any research involving construction would inevitably involve people.

The statement above also indicates the fact that in construction industry, people involved would have developed different "technology", aiming at achieving different "goals". In this regard, potential conflict of interests may exist between two or more groups of people if their goals are not exactly the same.

This is an important issue worthwhile to be mentioned in relation to BIM-related research. As viewed by Reddy (2011), BIM is a transformative technology as it will soon be used to change and improve construction processes. He also pointed out that "*BIM is changing the owners' processes and shaping the ways they do business*" (Reddy, 2011, p. 6). In fact, other than "owners", there are many other people involved in the construction activities and each of these people's own processes and way to do their business would also be shaped by BIM. As difference in business objectives are evident, it is very likely the benefits of transformation would be perceived differently in case there is any conflict in meeting each of their own business objectives.

In view of the above, in this project, not only ethical considerations on the impact upon people would be well considered but every attempt has to be made to avoid any intended/unintended favouritism or bias towards the goals of any particular group of people. Failing to do so, the interviewees might be impeded from conveying their genuine advice or responses.

The approach to be adopted could be summarized as 3C's, under Communication, Confidence and Confidentiality, as follows:

Communications – when conducting interviews, effort would be made to ensure all the respondents would understand clearly what shall be provided, why and how the collected information would be used. More importantly is that they would be well informed that the research objectives to be achieved is to provide recommendation for consideration or adoption but not intended for any overriding or governing rules for what to do.

Confidence – I would clarify to all respondent that I would be acting impartially. That is, I would not interfere individual disciplines status and/or any their future involvements in the construction business. Their advice/ responses would be collected, analysed and summarized to provide recommendations in best practice without any bias against any individual party or discipline. I would also inform all respondents that I myself would not have any vested interests from the research. While support would be sought from the industry, the research itself would not be linked to any pre-set objectives to be met by any organization, people, discipline or any particular works project etc.

I would also inform the interviewees that the compiled scripts/discussion summary would be forwarded to them for agreement/ comment before incorporation in the research project. However, if they consider this would be too time-consuming and prefer opting out, I would have their direction recorded properly and followed up accordingly.

Confidentiality – I would keep all personal information in a confidential manner and would not disclose any of such unless such information has already been publicized, or have been presented by the respondents themselves. I would not even ask any of the respondent to give consent in releasing their personal particulars. This is to avoid unnecessary change of minds by them due to adverse impacts caused by career switches or other situations.

For this research project, it is considered that anonymity in personal particulars could be maintained without affecting the intended outcomes/objectives to be met and this would also be informed to the respondents accordingly.

With respect to the originality of advice given during the interviews, I would provide details of my own contacts and post any updates to each of the interviewees. Instead, if they wish, they may approach me to obtain my consent to publicize the results/data that I have collected, after completion of the research project.

"Normal" ethics considerations

Other regular but essential approaches as listed below would be conducted to ensure proper ethics would be followed.

Secondary Research:

All references would be quoted properly. Supplements, personal comments etc., if any, would be clearly separated from the quotes but not immersed into the quoted statements.

Primary Research:

Where appropriate, the following would be observed/ proceeded with accordingly:

Pre-emption and Approval: invitation and agreement for interviews, etc, would be obtained and recorded in a formal manner formally before conducting or issuing

The interviewees: all the interviewees would not have direct employment or any commercial relationships with me. Their capacity would all be of external consultants or advisers, irrespective of their actual rank or position in their own organization.

I would clearly inform them that they always have their rights to participate, or to withdraw at any stage.

Place of interviews: due to COVID 19 issues, online interviews would be arranged instead of face-to-face meetings. As there are many other options for conducting on-line interviews, I would offer several options to the interviewees to respect their preferences.

Video or audio recordings of the interviews: formal consent from the interviewees for permitting the use of such in the interviews would be obtained prior to conducting of the interviews. As mentioned above, the interviewees would also opt to review/comment the compiled script before incorporation in the research project.

All records of interviews would be kept properly in a confidential manner, until the research project has been completed and fully approved.

3.11 Project Activity - The Planned and The Reality

3.11.1 Planned Project Activity

As a recap, the section above describes the planned methods and tools I would use to conduct the research in order to develop the Change Management Framework and to achieve the research objectives.

With the findings from the literature reviews, which have been conducted and reported in detail in Chapter 2, I have been able to master existing published or presented knowledge in both technological aspects and the complex and non-technological factors. Besides, these literature reviews have also equipped me with the capabilities in selecting and applying the appropriate methods for research information collection and analyses. In particular, the various model theories and approaches studied have enabled my understanding of the factors and criteria to be considered for change management.

Such enhanced knowledge, together with my own professional knowledge, proficiency and work experience, have enabled me to carry out the research works for the project involving various entities such as people, processes, workplace, disciplines, technologies and environments, etc., with complicated and complex inter-relationships with each other. I would therefore be able to carry out a holistic and comprehensive review of these factors in order to contribute advice and recommendations to the construction industry.

On the basis of the above, the project activity was planned as follows:

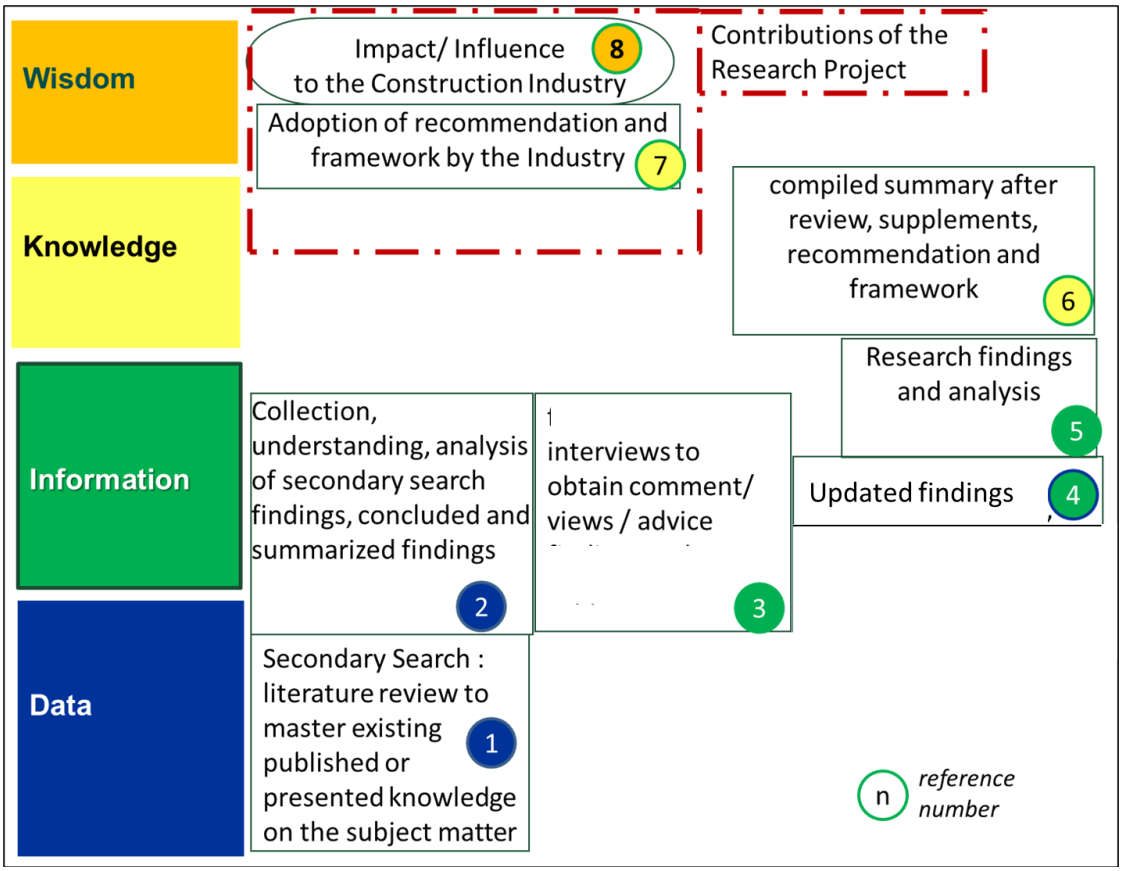


Figure 3-3 Planned Project Activity

3.11.2 Project Activity In Reality

While the project activities are carried out in accordance with the plans, the reality is that the actual processes are not as straightforward as the planned ones. Similar to those I have mentioned in Chapter 2 paragraph 2.4.1, about the culture knowledge model, the reality is "*not in such a "simple structure" and tidy manner as shown above but something messy…".* In this regard, while the report on Project Activity, Findings and Outcome would be covered in the later chapters, I would like to give a synopsis here on what actually have been done and what are the issues that have been encountered. In addition, the significance of the researcher's sound capability in conducting the research revealed during the project activities would also be addressed.

The actual processes of the project activities are much more complicated than the planned ones. This is caused mainly by the exhaustive requirements on inputs and the extensive volume of outputs. Figure 3-4 below is a flow chart capturing the major processes involved and consolidated in a nutshell.

While the flow chart is a consolidated one showing the major elements only, the complications and complexity of the processes could still be observed. Altogether in the Project Activity there are 14 major processes, each requiring different sources of inputs. Obviously, most of such required inputs would not be in existence. Much efforts have to be made to have them located, studied, learned, interpreted, analysed, summarized, etc. before implementation. The more important issue is that, for some of the processes, they could not be done in sequence, one after another. Instead, they need to be done in an iterative manner, i.e. to be repeated or redone again after some other processes have been done. Similarly, most of the outputs would not be valid until being produced but have to be reviewed, considered, addressed, referenced or used in other processes. These complications would not be that apparent in the following chapters as they have already been well complied, consolidated, encapsulated, or concluded before being presented.

On inputs, the crucial point that to be addressed is the part on my capacity in carrying out the project work. In the flowchart, it is shown by the legend  "Researcher's capability- professional knowledge, proficiency and work experience in related fields" (hereinafter known as the "capability").

Strictly speaking, such capabilities would be required for all the processes, I have not inserted it against all of them. Instead, before inserting the legend against each of the processes, I have evaluated the process by asking the following question:

"Can the process be done without my capability,
even that the outcome quality will be relatively lower?"

Only processes assessed with an "no" answer would be inserted with the legend. This would mean that for such processes, they could not be completed without my input.

As an example, according to my assessment, the process for "studies of Non-technological theories and issues" could be completed by a person without the necessary capability in BIM related topic, the answer to the assessment is therefore positive. As a result, the capability legend is not added against this particular activity.

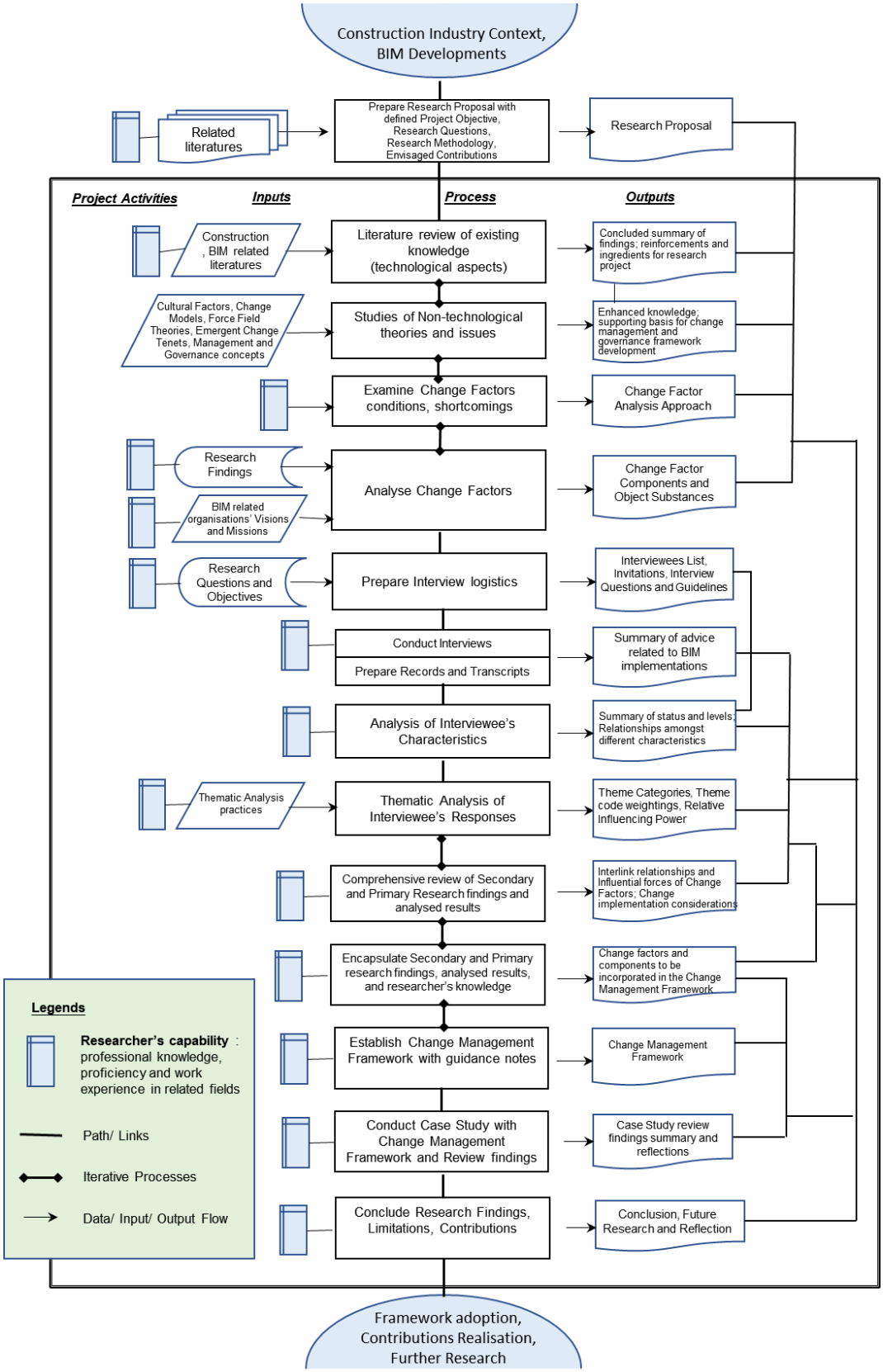


Figure 3-4 Project Activity Processes in a nutshell

Eventually, out of the 14 major processes, there are only two processes that would not require my capabilities. Besides the one mentioned above, another one is "Prepare Records and Transcripts". However, for this particular process, the assessment is confined to the clerical tasks involved in preparing the records and transcripts "*as they are*" only, i.e., without any understanding or interpretation about the contents. As a result, all the other 12 processes are tagged with the "researcher's capability" legends. This would evidently demonstrate the importance of the researcher's own knowledge about the project, in particular a project for a Doctor of Professional Studies degree that is designed to focus on the researchers' developments within their professional context.

3.12 Reflection

A plan is a plan. It could be observed from the above that the actual project processes are not the same as the plan. "Change" to the plan would be necessary to cope with the reality or otherwise the processes could not be continued in a satisfactory manner. However, the "change" is not unidirectional as the "actual" achievement may also deviate from the planned or expected one.

After completion of the originally planned and then the revised research processes, I find that I did benefit from my enrichment, in particular related to change factors coverage for the establishment of the Change Management Framework.

In addition to the expected outcome, I also find that together with my own capability, my skill in conducting research interviews has also been enhanced with the expert interviews having been conducted in an efficient and effective manner. Also, besides the achievement in obtaining their advice for meeting the research objectives, as unexpected "*windfall*", some of the interviewees even initiated and raised their views or ideas which are beyond my knowledge scope or even my awareness. Examples are *"Change Mindset or Change People"* (Chapter 5, paragraph 5.3) , and *"BIM to be perceived as a language"* (paragraph 5.8) etc. Such extras would not be there, if these interviewees have not been convinced by my capability and induced by the meaningful interview questions. These windfall contents are very encouraging and have added much motivation to my research works. In the next chapter, the report on all these and the actual project activities would be reported in detail.

Chapter 4 Project activity

4.1 Introduction

This chapter represents my research works activities after the approval for the research proposal and Research Ethics Application in September 2019. A copy of the Research Ethics Form is attached at Appendix 4 : *Research Ethics form (REf)*.

4.2 Secondary Research - The First Hard and Difficult Journey

In line with the approved proposal, the research journey began with the Secondary research, aiming to master existing published or presented knowledge on the subject matters of BIM, with a focus on the factors affecting its implementation.

As mentioned earlier, "complexity is a key characteristics of construction projects" (Brockmann and Kähkönen, 2012, p. 716) and soon after the research, it is found that the influencing factors are even more complex. There is quite a big truck of literature on the factors, mostly on benefits and barriers. However, the factors are either descriptive involving lengthy sentences or illustrative with key words only. Both types of factors impose the same difficulty in converting into self-explanatory elements for inclusion in the proposed Change Management Framework for use by the target users.

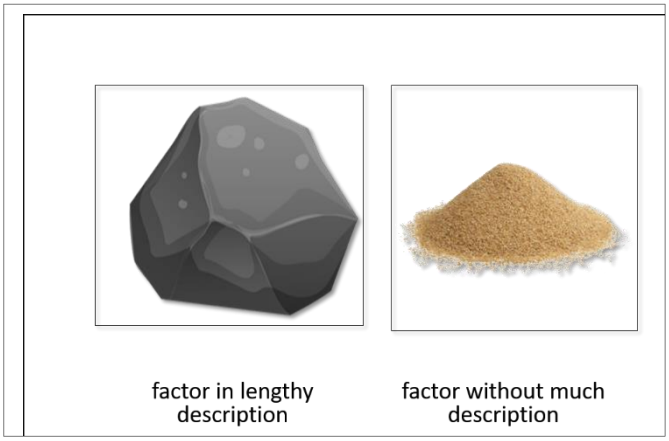
As an illustration, in one of the papers, the benefit factor is described with lengthy sentences:

> "When the owner uses Integrated Project Delivery (IPD) for project procurement, BIM can be used by the project team from the beginning of the design to improve their understanding of project requirements and to extract cost estimates as the design is developed. This allows design and cost to be better understood and also avoids the use of paper exchange and its associated delays." (Eastman, 2011, p. 21)

While in another paper, only very concise description (or even none) of the benefits is described as follows:

> "BIM approach has a lot of benefit after good implementation of the standard and guide, best practices." (AUNG, 2018, p. 21)

As a metaphor, there are two extremes of factor types. One of them looks like a big boulder that contains a lot of contents which are difficult to be extracted for justifying the framework. Another extreme are "tiny" dispersed factors that look like sand which are easy to handle but could not help much in building the framework.



With the cumulative collection of more of the factors from the literature, the complexity also grows, in relation to locating relationships between the factors.

Many scholars have in fact suggested different ways in classifying the data. For example, Sun *et al.* (2017) classified the benefits under their nature in five categories: Technology, Cost, Management, Personnel, and Legal (Sun *et al.*, 2017). While in another paper, the benefits are categorized under different roles of the parties involved, namely "Benefits of BIM to Clients and Owners" and "Benefits of BIM to Designers and Constructors" (Halttula, Haapasalo and Herva, 2016).

However, in the same paper, Halttula used another approach for categorizing of the barriers as follows but not delineating the parties by their roles:

- ICT (Information and communications technology) related barriers
- Resistance to Change Barriers
- Interoperability or Similar Problems
- Organisational and Common Process-based Barriers
- Training and Knowledge-based Barriers

With such different classification approaches, the complication nature of the factors is not released but the situation has become even more chaotic. In particular, there is not any appropriate way in representing the factors not only in a comprehensible manner but also be able to demonstrate the relationship between the driving or restraining forces imposed by the factors.

As a recap, the research project I propose to undertake is to carry out an in-depth review of the factors in Building Information Modelling (BIM) implementation. This is achieved by analyzing the research findings that aims at concluding and incorporating them for sake of building up a Change Management Framework in the context of the construction industry. The framework would

be pragmatic, providing unbiased and factual findings, clear and concise summaries of the research results and recommendations.

Since "factors on BIM implementation" is the major and fundamental element in the intended framework for change management, such factors ought to be identified and analysed, then summarized and presented flawlessly. This has to be done before carrying on the remaining part of the research. However, the struggle has been in existence for a considerably long period, and the situation has become even worse with a legacy of the data on factors piling up from further literature reviews.

Fortunate enough, there was a breakthrough.

4.3 The breakthrough

The term "breakthrough" could explain the approach to overcome the last hurdle. It was during a discussion with a professor in building technology that showed me a picture about concrete mixing from a lecture. He told me that he had informed the class the fundamental principle that for quality concrete mix, aggregate of suitable size should be used, and that sand was also important in filling up the voids in between.

His intention in telling me all these was to point out that, nowadays, very often such fundamental principles were not taught because they were considered to be too basic for university students. However, such fundamental principles did awake me from the dark. I reckoned that after the big boulders (factors with lengthy descriptions) were broken down into bites, they would become usable. On the other hand, sand (factors without much description) could be used as supplements.

To conclude, after appropriate treatments the "big boulder" and "tiny sand" factors would become useful as in the case of concrete mixing, where the aggregate, sand and other ingredients are mixed and converted into concrete of the appropriate mix.

With the concept from this breakthrough, I could begin to analyze the factors (boulders and sand) successfully and eventually used them to establish the Change Management Framework (concrete). The following paragraphs would address to the approach in breaking down the significant factors of "big boulders" and the use of the small factors of "sand". The other components for establishing the Change Management framework would be represented later.

4.4 Breakdown of "Factors"

4.4.1 The Fundamental Concepts and Definitions

The fundamental principle for concrete mixing also reminded me that very often the fundamental composition of the item in concern would help explain the scenario, thus provide supporting the basis for further developments. In this regard, the basic meaning of "factor" and "change" have been investigated. After that, attempts have been made to break down the term "factor" into appropriate segments and build up the ideology of change factors.

4.4.2 Literal Definition of Factor

The definition of "factor" given in the Oxford Learner's Dictionary is as follows:

"factor: one of several things that cause or influence something"

This definition indicates that in a "factor", there are a couple of "things", one being the "thing" causing the influence, and the others ("something") being influential. These two categories of "things" would be used as the "segments", being the basis for breaking down the term "factor".

Segment 1: The "thing" causing influence is named as the "subject" matter.

Segment 2: the "something" being influenced is named as the "object" matter.

4.4.3 Developed Definition and Composition of "Change Factor"

For change, the definition given in the same dictionary is:

"change: an act or process through which something becomes different"

So "change" can be interpreted as the link between the two building blocks of "subject" and "object" matters, in the sense that "Subject"⇔ "Change" ⇔ "Object".

In this regard, for this research project, the above building blocks and link are grouped and collectively named as the "Change Factors", as defined below:

"Change Factors: things that cause influence on and subsequently change something"

Following this above, the "Change Factors" comprise of two major substances, namely:

(1) substance of the "things" causing the influence, i.e., the "subject" causing the influence, and

(2) substance of the "things" that are being influenced and changed, i.e., the "object" being influenced.

For this research project, the substance of the "things" in (1) are named as "Subject Substance (SS), and those in (2) are "Object Substance (OS)".

In line with the above, the composition of the term "Change Factor" to be adopted for this research project is as follows:

"Subject Substance (SS) with Subject Attribute (SA) that cause influence on and subsequently imposed change (OC) on Object Substance (OS)"

The following fundamental economic principles in the "law of supply" are used to illustrate how the above breakdown of the term "factor" would be used and further developed to explain for the "Change Factor" composition:

> Principle (A) "when <u>supply</u> exceeds demand for a good or service, <u>prices</u> fall." and
> Principle (B) "when <u>demand</u> exceeds supply, <u>prices</u> tend to rise."

In Principle (A), the "Subject Substance" (the "things" that are causing the influence) is "supply", the "Object Substance" (things that are being influenced and changed) is the "prices". Similarly in Principle (B), the Subject Substance is "demand", and the Object Substance is "prices".

However, the above naming would illustrate the part on "substance" of the Subject and Object only. In order to achieve a comprehensive understanding of the term "Change Factors", further supplements with "Attribute" and "Change" on the Subject and Object are required. These will be elaborated in detail below.

Subject Substance (SS) and Subject Attribute (SA)
The Attribute of a Subject refers to the properties/function/capabilities etc. of the Subject substance, i.e., the conditions, nature, status etc. of the Subject substance, which are mainly related to the influences imposed on the Object substance.

In Principle (A), "*exceed (in) demand*" would be the Attribute of the Subject Substance (the "Supply"), which causes influence on the Object substance (the "Demand").

Similarly, in Principle (B), the attribute of the subject "demand" is "*exceed (in) supply*", causing influence on the object "price".

Object Substance (OS) and "Change on Object Substance" (OC)
There would be "change" or "effect" to the Object Substance under influence. For this research project, such change or effect would be named as "Change on Object Substance" (OC), i.e. the resulting change(s) to the Object Substance after being influenced by the Subject Substance.

In Principle (A), the "Change on Object Substance" for the "prices" is "***rise***". In Principle (B), the "Change on Object Substance" on "prices" "***tend to fall***".

4.5 Change Factor Analysis

As a summary of the above, there are two components "change factor", namely, **Subject and Object,** with the associated "substance" and "attribute" or "change", as follows:

Subject: The Subject Substance (SS) and its Attribute (SA);

Object: The Object Substance (OS) and the resulting "Change on Object Substance" (OC) after it has been influenced

The Change Factor Components derived from the application on "Law of Supply" principles could be illustrated as follows in a tabulated format:

	Subject of Change Factor		Object of Change Factor	
The Context	Subject Substance (SS)	Subject Attribute (SA)	Object Substance (OS)	Change on Object Substance (OC)
Economic principles in the "Law of Supply":				
Principle (A) "when **supply exceeds demand** for a good or service, **prices fall**."	Supply	exceeds demand	Price	fall
Principle (B) "when **demand exceeds**	Demand	exceeds supply	Price	tend to rise

supply, **prices tend to rise**."				

Table 4-1 Change Factor Components in the "Law of Supply"

The intention of the approach above is to break down the change factors instead of redefining them into something new or creating new definitions. Instead, this practice can serve as a structure for clear presentation of the substances involved, the influence being exerted by the Subject and the effect being imposed by the Object. Since the change factors to be considered for BIM implementations are complex and complicated in nature, such structured arrangements would give a clearer picture for management of the change implementation processes.

The procedures involved in the separations as described above might sound a bit excessive but is considered vital for this research project. This is because by doing so, I would be able to break down the factors with lengthy description, as well as building up the "factor without much description" to a common platform or level, so as to enable summarizing, analyses and clear presentation for the establishment of the Change Management Framework. For this research project, this analysis is named as the "**Change Factor Analysis**".

4.6 The Analysis

4.6.1 Analysis of Findings from Secondary Research

Based on the Change Factor Analysis approach as mentioned above, the first lot of data are factors found in the literature review. The objective is to identify and analyse the factors related to BIM implementation and then transform them into meaningful and useful information.

Procedures resembling the Thematic Analysis are used in the analysis. The procedures are found to be similar, because not all the procedures adopted are copied from those in the thematic analysis in order to cater for the particular needs of this research project. The major difference between the two is that, for "Change Factor Analysis", the target is to list as many factors to be considered for change implementation as possible, instead of identifying the pattern behind the factors.

The Phases of Change Factor Analysis adopted for this research project, with notes on comparisons with those in the Thematic Analysis phases, are as follows:

Phase		Change Factor Analysis processes and notes
1	Familiarizing with the data	Reading and re-reading of the data, noting down the context on factors affecting BIM implementation.
2	Generating initial factor components	Instead of coding in the Thematic Analysis, the context of the findings is split into appropriate components in the Subject of Change Factor and Object of Change Factor.
3	Reviewing factor components	The initial factor components are reviewed and analyzed to break down the factors into the four components, namely, the

Phase		Change Factor Analysis processes and notes
		Subject Substance (SS), Subject Attribute (SA), Object Substance (OS), and "Change on Object Substance" (OC)
4	Iterative analysis and review	The components are analysed and reviewed in an iterative manner until the appropriate factors are grouped under a common and standardized name.
5	Producing the list	After several rounds of reviews, the final round of the analysed data in standardised factor wordings is derived. In order to enhance their comprehensibility, the four components are listed in the pattern of a sentence like structure as follows: "The Subject Substance's Attribute" "change" "the Object Substance" (i.e., SS, SA, OC, OS). While the pattern of SS, SA, OS and OC has been adopted in the analysis process, it is more convenient in development of these components in this context.

Table 4-2 Change Factor Analysis Approach

4.6.2 Phase 1 and 2 Analysis

After completion of Phase 1 – Familiarisation of data, each of the context noted down is abstracted and split into initial component segments. The raw data of context and segments are listed in table form under the following headings:

Context: The abstracted text from the reference;

Reference: the citation or source;

Initial Component Segments: Subject Substance (SS), **Subject Attribute** (SA), **Object Substance** (OS) **and Change on Object Substance** (OC). (Please refer to paragraph 4.5 Change Factor Analysis for detailed descriptions of the components.)

Below is a table showing the headings of the result list:

		Initial Component Segments			
Context	**Reference**	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC)**

The full set of the abstracted context and initial component segment are listed in Appendix 5 *: Raw data and initial Change Factor Components.* At this stage, the data recorded and listed are in their raw form only without in-depth analysis.

4.6.3 Phase 3 Analysis

In Phase 3, the raw data recorded and initial component segments are reviewed and analysed to form the first round of Change Factor Components. The results are listed in a table with the following headings:

	First Round Review and Analysis Results			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC**

The full set of the analysis results of the First Round review is attached in Appendix 6 : *Results of the first round review and analysis*.

4.6.4 Phase 4 and Phase 5 Analysis

In the above analysis phases, the sequence of SS, SA, OS and OC are used as this pattern of headings is more convenient in splitting the segments and development of the components.

In Phase 4 analysis, the components derived from Phase 3 are reviewed in an iterative manner until the appropriate Change Factors are collated and grouped under a common and standardized name. In order to enhance the comprehensibility of the findings, the four components are listed in a revised pattern, similar to those of a sentence structure, as follow:

"The Subject Substance's Attribute" "change" "the Object Substance" (i.e., in the revised sequence of SS, SA, OC, OS).

Below is the table showing headings of the Final Round Analysis Results with samples showing the revised pattern:

	Final Round Analysis Results with Key words labelling			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Change on Object Substance (OC)**	**Object Substance (OS)**
Allow the checking of architectural design of buildings from the sustainability point of view.	BIM Model	visualisation capability	improve	design process
Support collaboration and ease procurement relationships	BIM Process	collaboration capability	improve	collaboration process

The full set of the Final Round results with the analysed data in standardised factor wordings as derived is attached in Appendix 7 : *The Final Round Analysis Results with Labelling*.

Each of the Change Factor Components is reviewed in an iterative manner until components with similar nature/ properties are grouped under a standardized name.

Table 4-3 below is a summary of the Components (with standardised names) identified from the Final Round Analysis results. Since the number of the Object Substance (OS) is very long, it is split and shown under two columns.

As an initial indication, it could be observed that quite a variety of Object Substance are present, showing that different parties would have different objectives to be achieved. One of the reasons behind is that in the construction industry, there are various parties of different disciplines, and varied objectives to be achieved, including those related to the changes.

For effective change implementation, a clear focus on which of the Object Substances should be changed would be essential. Otherwise, the changes would not bear a clear goal and could not be implemented in a sound manner. The Object Substances (OS) identified above are based on those derived from literature reviews only. Further review and analysis of such Object Substances based on appropriate practitioners or stakeholders' views, would be conducted in the later part of this research project, as a Primary Research.

Subject Substance (SS)	Subject Attribute (SA)	Change on Object Substance (OC)	Object Substance (OS) - column 1	Object Substance (OS) - column 2
BIM Model	Activeness	decrease	adoption pace	facilities resources planning performance
BIM Process	Adoption resistance	encourge	alternatives design process	financial opportunities
BIM software	analysis capability	enhance	approval processes	geen implementation process
Government leadership	asset life long coverage	improve	as built drawings preparation cost	green implementation
construction industry	clash detection capability	increase	BIM adoption pace	information exchange process
Approval process	collaboration capability	reduce	BIM implementation pace	innovative proposal capability
BIM Technology	data management capability	slow down	building performance quality	investment opportunities
contruction industry participants	design function	speed up	building performance simulation process	layout design process
BIM software	doubts on benefit		built asset performance	ligitation risk
	guidance capability		client's market share	management of environmental data
	information sharing capability		collaboration process	new method adoption
	integration capability		collaboration process	predictive analysis
	simulation capability		construction processes	procurment process
	traditional approach		contractual claims	project performance
	visualisation capability		control of lifecycle costs	project quality
			coordination process	project requirements understanding process
			data integration process	reasoning design process
			decision-making process	resources management
			design accuracy level	safety and health performance
			design analysis process	site safety risk
			design performance	statutory approval process
			design process	sustainability performance
			documentation process	sustainable material selection process
			energy usage simulation process	understanding design process
			environmental protection performance	wastage output
			existing buildings fitting out design process	waste output

Table 4-3 Summary of Change Factor Components

4.6.5 Analysis of Organisational Change Factors

As mentioned earlier, organisational change is considered to be relevant for BIM implementations in the context of the construction industry as an organization. In this regard, the factors affecting organizational change would largely be applicable for the construction industry.

"*Change must be initiated with a vision in mind, as it clarifies the future goals of the organization to the stakeholders*" (Business Jargons, 2020). In line with this, the vision and mission of the organisations would also be a crucial factor any change implementation. As *"…it is necessary to create and communicate the vision to the affected parties, so that they are aware of the fact that why change is being implemented*" (Business Jargons, 2020).

For the construction industry, establishment of the vision and mission on the change for BIM implementation would be one of the crucial factors, or in other sense, an indicator of their intention to implement change towards this area.

Hence, an analysis of the visions and mission published by the relevant organisations in the construction industry have been conducted to reveal the current level of determination in making the change. This could be reflected on the coverage of "Object Substance" in their vision and mission statements. The more coverage the Object Substances materialises, the more determination in achieving the change towards the Object Substance would be indicated.

4.6.6 Analysis of Organisations' Vision and Mission

As an attempt to ensure that construction professionals have the appropriate skill levels and competency in using BIM technology, and to facilitate the healthy development of BIM, the Hong Kong SAR Construction Council introduced the BIM Certification Schemes in 2020 for certifying BIM personnel with appropriate competency as BIM Managers.

Based on their latest published list as at September 2020, there are 320 Certified BIM Managers, with 144 of them have included the names of their employing organisations (HKSAR Construction Industry Council, 2020). After review, it is found that these BIM managers are in fact employed by 84 different organisations.

These companies, with BIM Managers appointed, should have adopted or as least intended to adopt or promote BIM implementation. As mentioned above, their vision should also cover this aspect for effective change implementation. The Vision and Mission statements of these organisations would serve to indicate their level of determination for BIM implementation, or at least if there is such a goal in focus.

The research on this aspect first started with searching the vision and/or mission statements which have been posted on their websites. In case there is no specific vision or mission statement, other similar statements or quotes would also be considered.

The procedures for Change Factor Analysis as described above would also be used, yet for this particular aspect, only the Object Substance and Change on Object Substance because normally the vision and mission statements would cover the targets to be achieved (the Objects) but not the method or way (the Subjects) to implement the changes.

4.6.7 Summary of the Analysis for Change Factors based on Visions and Mission of Organisations

The source and data abstracted, the analysis and listing of the Object Substance (OS) and Change on Object Substance (OC) are summarised in Appendix 8 - Primary Research Analysis (altogether in three parts).

Part (1) of this Appendix is a table which lists the abstracted vision, mission and related statements only. The headings of the table are as follows:

Company	**Vision**	**Mission**	**Others**

(Table headings of Appendix 8 - Part (1) : *Abstracted Vision, Mission and related Statements*)

Part (2) of the Appendix is a list of the initial segments established from the statements. As the statements may cover more than one Object substances and the Change on Object Substance, each of them is allocated with four pairs of such components. Should there are more than four sets, the most significant four pairs would be used. The headings of the table are as follow:

Object substance 1	Change on OS 1	Object substance 2	Change on OS 2	Object substance 3	Change on OS 3	Object substance 4	Change on OS 4
OS01	**OC01**	**OS02**	**OC02**	**OS03**	**OC03**	**OS04**	**OC04**

(Table headings of Appendix 8 - Part (2) : *Initial segments established from the statements*)

Similar to those for Change Factor Analysis, iterative review and analysis of these initial components have been conducted to derive the final version. The results of the final round listing, are attached at Part (3) of the Appendix, with the headings as below:

Change on OS 1	Object substance 1	Change on OS 2	Object substance 2	Change on OS 3	Object substance 3	Change on OS 4	Object substance 4
OC01	**OS01**	**OC02**	**OS02**	**OC03**	**OS03**	**OC04**	**OS04**

(Table headings of Appendix 8 - *Part (3) : Results of the Final Round* Listing)

Based on the final round listing, the summary of the relevant Object Substances, listed in alphabetical order, is found as follows:

Relevant Object Substances
Awareness of health and safety
Best practice processes
Business opportunity
Change
Clients' requirements
Communities' needs
Competencies
Construction industry performance standard

Contemporary living culture
Continuous improvement
Corporate citizen reputation
Corporate social responsibility
Cost effectiveness
Decision making process
Design process
Employees’ career
Employees’ number
Employees’ satisfaction
Employees’ work-life balance
Innovation
Leadership of the organisation
Living quality
Long term investment
New technology
Prediction of changing human behaviour
Process automation
Professional institute status
Professionalism
Project quality
Rational use of public resources
Relationship with worldwide
Research education
Safe environment
Scholarship bounds
Security environment
Services quality
Skills development
Social advancement
Society
Staff mindset for change
Sustainability
Technical excellence
Tender performance
Work environment
Workflow automation

4.6.8 Change Factor Object Substances Analysis from Literature Review and Organisations' Vision and Missions

Altogether 94 Object Substances have been identified in the Change Factor Analysis from Literature Review (L) and Organisation' Vision and Mission (V). They are then combined together to reveal if there are any common Substances covered in both of them. All these 94 identified Object Substances (OS) are listed in alphabetical order in the table below, with the common items highlighted in green and in bold and italic font:

Object Substance (OS) Identified	**from literature (L); from Vision or Missions etc (V)**
Adoption pace	L
Alternatives design process	L
Approval processes	L
As built drawings preparation cost	L
Awareness of health and safety	V
Best practice processes	V
BIM adoption pace	L
BIM implementation pace	L
Building performance quality	L
Building performance simulation process	L
Built asset performance	L
Business opportunity	V
Change	V
Clients' requirement	***L***
Clients' requirement	***V***
Collaboration process	L
Communities' needs	V
Competencies	V
Construction industry performance standard	V
Construction processes	L
Contemporary living culture	V
Continuous improvement	V
Contractual claims	L
Control of lifecycle costs	L
Coordination process	L
Corporate citizen reputation	V
Corporate social responsibility	V
Cost effectiveness	V
Data integration process	L
Decision making process	***V***
Decision-making process	***L***
Design accuracy level	L
Design analysis process	L

Object Substance (OS) Identified	from literature (L); from Vision or Missions etc (V)
Design performance	L
Design process	***L***
Design process	***V***
Documentation process	L
Employees' career	V
Employees' number	V
Employees' satisfaction	V
Employees' work-life balance	V
Energy usage simulation process	L
Environmental protection performance	L
Existing buildings fitting out design process	L
Facilities resources planning performance	L
Financial opportunities	L
Green implementation process	L
Information exchange process	L
Innovation	V
Innovative proposal capability	L
Investment opportunities	L
Layout design process	L
Leadership of the organisation	V
Litigation risk	L
Living quality	V
Long term investment	V
Management of environmental data	L
New method adoption	L
New technology	V
Prediction of changing human behaviour	V
Predictive analysis	L
Process automation	V
Procurement process	L
Professional institute status	V
Professionalism	V
Project performance	L
Project quality	***L***
Project quality	***V***
Project requirements understanding process	L
Rational use of public resources	V
Reasoning design process	L
Relationship with worldwide	V
Research education	V

Object Substance (OS) Identified	from literature (L); from Vision or Missions etc (V)
Resources management	L
Safe environment	V
Safety and health performance	L
Scholarship bounds	V
Security environment	V
Services quality	V
Site safety risk	L
Skills development	V
Social advancement	V
Society	V
Staff mind set for change	V
Statutory approval process	L
Sustainability	***V***
Sustainability	***L***
Sustainable material selection process	L
Technical excellence	V
Tender performance	V
Understanding design process	L
Wastage output	L
Work environment	V
Workflow automation	V

Table 4-4 Total listing of the Object Substances identified in the Analysis

It could be noted that there are only 5 common items. They are:

- Clients' requirement
- Decision making process
- Design process
- Project quality
- Sustainability

This indicates that, at this stage, in line with the analyses of the 144 organisations' vision for future goals, currently only 5 Object Substances are the same with those identified in the literature review.

4.7 Reflection

With the results from the analysis above, it is considered that that a rich description of the data set is provided to enable readers to have a thorough understanding of the predominant and important elements about the factors to be considered in BIM implementation. However, these factors should not be treated as a comprehensive list, and in fact this is not the project objective. Using what has been said in the paper "Using thematic analysis in psychology" (Braun and Clarke, 2006) as the

basis, the findings established might not be the most prevalent factors across the entire data set. As a result, the essence of such findings is not intended to be full and comprehensive in meeting all changes requirements, and that further reveal other essential factors.

The findings from the above, together with concepts and principles about the non-technical factors learned from the studies of change theories and models etc. as described in Chapter 2 Literature, Knowledge and other Information Review, would form part of the proposed Change Management Framework.

4.8 Primary Research

It is worthwhile to mention here that while the above is reported under secondary research, it could also be regarded as part of primary research because it involves not only collection and/or rearranging of data only but also analysis of the data nature.

Also, the processes above have been used for replacing the questionnaires because they would achieve the targeted outcomes and even in a better manner, in particular under the current distressing mode in the industry, and in the pandemic-ridden world. The justification is that in most of the cases, when responding to questionnaires or questions in the interview, the answers given by the respondents would be confined to those the subject considered as appropriate for releasing to the public only. It would be very difficult to obtain answers from them beyond this hidden boundary. It is considered that even the questionnaires cover the same for the change factors, answers more or less (normally less) the same would be obtained.

As a further merit over questionnaire, the analysis results above could serve as a benchmark. Where necessary, the same analysis could be conducted to reveal the differences, if any, in the change factors and common Object Substances, without issuing any additional questionnaire. Just as an example for illustration purpose, in case if all the organisations' visions are covering the relevant change factors for BIM implementation. it would indicate that all such organisations are aiming to change for it with very high priority and possibly in full force.

4.9 The Interviews

Another part of the primary research on interviews have been conducted in line with the approved research proposal. The objective is to seek advice from the interviewees on factors / issues that need to be considered based on their involvements, experience and insights. Below is a summary of the sampling method, interviewee selection and interview invitation processes.

4.9.1 Sampling method

The selection of an appropriate sampling method is important because it would significantly affect the credibility of the outcomes. It is therefore necessary to ensure that the appropriate method for selection of samples would be used in order to meet the research objectives.

There are various types of sampling methods. Globally, McCombes (2022) categorised them under two categories, viz, Probability sampling and Non-probability sampling. (McCombes, 2022)

4.9.1.1 Probability Sampling Method

For probability sampling, McCombes (2022) addressed that it "*is mainly used in quantitative research*" (p. 1). Palinkas *et al.,* (2015) named this type of sampling as "*probabilistic or random*

sampling" and described that it "*is used to ensure the generalizability of findings*" (Palinkas *et al.*, 2015, p. 534).

From the above, it could be noted that this type of sampling method would not be a matching one for this project because the nature of the interviews to be conducted is qualitative rather than quantitative. Also, as mentioned in paragraph 3.1 of Chapter 3, the objective is to obtain experts' views, advice and recommendations in the practical field, generalisation of findings is not the goal to be achieved.

Regarding selection of respondents, Nikolopoulo (2022b) defined probability sampling as "*a sampling method that involves randomly selecting a sample, or a part of the population that you want to research*" (Nikolopoulou, 2022b, p. 1). For this project, random selection would pose high risk to invitees who do not process the required abilities and thus would impede the achievements of the research objectives.

In view of the above scenarios, the probability sampling method is considered to be inappropriate for this project.

4.9.1.2 Non-probability sampling method

For the method of non-probability sampling, Niko Nikolopoulo (2022a) defined it as "*a sampling method that uses non-random criteria like the availability, geographical proximity, or expert knowledge of the individuals you want to research in order to answer a research question"* (Nikolopoulou, 2022a, p. 1).

McCombes (2022) explained that for this type of sampling, "individuals are selected based on non-random criteria", and that the aim is "*to develop an initial understanding of a small or under-researched population"* but "*not to test a hypothesis about a broad population*" (McCombes, 2022, p. 7).

From the above, it could be observed that non-probability sampling would be more appropriate for this project in terms of objective achievement and control mechanism on interviewee selection.

There are also many types of sampling in this method. For this, Galloway (2005) says that there are five main types, namely, Convenience, purposive, quota, snowball, and self-selection. (Galloway, 2005, p. 859). Below is a summary of the definitions and applications given by Galloway (2005), and the review of the appropriate methodology for the selection of interviewees:

Sampling Method	Abstract of definition	Review notes
Convenience Sampling	"*Convenience sampling involves using respondents who are "convenient" to the researcher"* (p. 860).	Galloway (2005) pointed out that there will be "*no pattern whatsoever in acquiring these respondents*" (p.860). In this regard, if this method is selected to be the intended objective of selecting people with appropriate knowledge and

Sampling Method	Abstract of definition	Review notes
		expertise, the outcomes could not be ensured.
Purposive Sampling	*"... those using a purposive sample will endeavour to direct their survey at a range of respondents who are ultimately representative of at least the extremes of variables under consideration*" (p.860).	This type of sampling method matches with the intended selection criteria in full. More details would be covered in paragraph 4.9.2.
Quota Sampling	"*Quota sampling tries to replicate proportions of demographic factors ..."* (p.861)	After giving the definition of quota sampling, Galloway (2005) said that "whereas, in purposive sampling, researchers may be satisfied merely to include a reasonable range of the variables being examined" (p.861). Again, this further suggests that purposive sampling is more appropriate for this project.
Snowball Sampling	"*Just like a snowball gets bigger when rolled in snow, a snowball sample increases in size as a small number of potential respondents suggest the names and/or addresses of other people who fulfil particular criteria"* (p.862).	This sampling method would be for researchers who do not have adequate number of suitable respondents. I did not find this approach suitable because as mentioned in Chapter 3, paragraph 3.10, with my contributions to the construction industry, I was able to establish the appropriate network for compiling the list of appropriate respondents.
Self-selection Sampling	*"A self-selected sample is simply one in which the respondents put themselves forward for participation in a survey or similar form of research"* (p.863).	Galloway (2005) commented that "*The possibility of bias in the sample is extremely high, because those most likely to put themselves forward are those who have a particular interest*" (p. 863). In this regard, this sampling method is not appropriate for application because the interview results should not be biased.

As indicated from the reviews above, purposive sampling is the most appropriate approach to be adopted for this project. Since the goal of conducting the interviews is to seek advice from the appropriate experts, I do need to exercise judgement on the interviewees to be invited, substantiation of the suitability of this method can be further illustrated from the following statements by Nikolopoulou (2022c):

"*The main goal of purposive sampling is to identify the cases, individuals, or communities best suited to helping you answer your research question*." and "*Also called judgmental sampling, this sampling method relies on the researcher's judgment when identifying and selecting the individuals, cases, or events that can provide the best information to achieve the study's objectives*" (Nikolopoulou, 2022c, pp. 1–2).

As a conclusion, the purposive sampling method is considered to be most appropriate and will be adopted for selection of the interviewees. Below are the processes in establishment of the interviewees list.

4.9.2 Criteria and Establishment of Interviewees List

As pointed out by Peters , *"…good respondents are those that understand the project culture and operations, and are able to reflect on these"* (Merriam and Tisdell, 2015 cited in Peters, 2020, p. 1). In response, Peters also advocated that in order to ensure the data to be collected is balanced and "*reflects the opinions and experiences of the population under study*" (Peters, 2020, p. 1). In this regard, a range of people with different backgrounds and experiences, who have different opinions on, or experiences on the subject matter, shall be interviewed. Regarding the selection criteria, Peters viewed that the interviewees shall be those "*able to understand the role of the researcher, and offer a perspective on the topic, while expressing opinions, thoughts, and feelings reflectively*" (Peters, 2020, p. 1).

With the above in mind, for effectiveness, , I would invite "*a range of respondents who are ultimately representative of at least the extremes of variables under consideration*." as defined by Galloway (2005, p. 860).

On "range of respondents", I would only invite "good respondents" who are considered to be *"…those that understand the project culture and operations, and are able to reflect on these"* (Merriam and Tisdell, 2015 cited Peters, 2020, p. 1). That is, respondents who are involved in implementation of Building Information Modelling (BIM) would be invited only.

Regarding representativeness, both the "breadth and depth" of the range of respondents are considered. On "breadth", interviewees from different sectors of the construction industry were invited so that their feedback would cover all stages of a construction life cycle, namely the planning, design, construction, maintenance and operation stages. In addition, interviewees from the academic sector were also to be invited as they are also one of the stakeholders in the construction industry. In this regard, altogether interviewees are mainly from six sectors as follow:

	(*planning and design stage)*
(1)	Developer/ Owner organisation sector;
(2)	Design Consultants sector;
(3)	BIM Consultants sector;

	(construction stage)
(4)	Contractors sector;
	(maintenance and operation stage)
(5)	Property/ Facilities Management sector;
(6)	Academic sector.

In terms of "depth", for each of the sectors, interviewees at strategic/ decision making level and executive/ operational levels are to be invited. People at the different levels would have different role and responsibilities. As a result, their views might not align or be congruent, and might even conflict with each other and would serve as "extremes of variables under consideration" as mentioned by Galloway (2005). With this, the feedback from the interviewees would balance each other. In this regard, interviewees from two different groups of people are to be invited, namely,

(a) Directorial/ Managerial group for people being engaged with responsibilities in decision making, managerial works etc.; and
(b) Executive/Operational group for those being responsible for managing or carrying out the works.

In line with the above, a total of 12 interviewees (2 groups for each of the 6 sectors) are to be invited. It could be foreseen that feedbacks from interviewees of such widespread sectors and board responsibilities coverage would be of significant and of representative nature.

As mentioned in Chapter 3, paragraph 3.10, with my contributions to the construction industry, I was able to establish the appropriate network and thus the access to people for compiling the list of interviewees. Hence, a prioritised list of interviewees for each of the six sectors was drawn. The criterion of prioritization is the level of likelihood of their agreement to participate in the interviews. Out of the first lot of invitations sent to twelve potential interviewees with the highest priorities, nine of them have replied and advised their agreement to attend the interview. Three of them did not respond even after a gentle reminder.

Instead of further pursuing for their agreement to participate, I sent invitation to three other potential interviewees, who worked under the same category and responsibilities group of the respective non-respondents. Finally, agreements from all of them were received and a list of twelve interviewees was established according to the target.

4.9.3 Interview Schedule

All twelve interviewees were then debriefed about the research project in line with the approved Debriefing Sheet. Upon receipt of their agreement to take part, each of the interviewees was assigned with a Participant Identification Number (PIN). A formal invitation for an online interview, together with the Participant Information Sheet (PIS), Consent Form, and Interview Guide were then sent to each of them. All the interviews were conducted in July and August 2021, in accordance with their preferred timeslots and dates.

Below is a listing of the participants identification number, sector and meeting schedules:

List of Interviewees and Schedule of Meetings

Sector	Participant Identification Number	Interview time/ date
Developer/ Owner organisation	DO101	4pm, 28 July 2021
	EP101	3pm, 16 Aug 2021
Design Consultants	DC101	10am, 22 July 2021
	ED101	2pm, 13 Aug 2021
BIM Consultants	BC301	3pm, 20 July 2021
	CD301	2pm, 27 July 2021
Contractors	DS401	10:00 am, 19 Aug 2021
	CR401	4:30pm, 21 July 2021
Property/ Facilities Management	QG501	8:30pm, 26 July 2021
	PF501	4:30pm, 18 Aug 2021
Academic	BE601	2:30pm, 27 Aug 2021
	AD601	2pm, 19 July 2021

Prior to the interview, each of the participants was provided with the Participant Information Sheet (PIS) and Consent Form which had been prepared in accordance with the those approved for this research ethics application. All the participants signed and returned the consent form. A blank template for each of them is attached in Appendix 9: *Master copy of Participant Information Sheet (PIS) and Consent Form*.

4.10 Interview Questions and Guide

As mentioned in paragraphs under 1.4 Objective of the project and Research Questions, the following objectives, as covered in the PAP, to be achieved for this research project are as follow:

OB1: to review and identify the underlying barriers[#] in BIM implementation that have been in existence and still exist, and those newly arisen after the mandate of BIM use by the Hong Kong Government;

OB2: to review and evaluate the rationale behind of the existences and the impacts of such barriers[#] on the BIM implementation processes;

OB3: to review and analyze practical problems and influencing factors that would also have effect on successful BIM implementation processes;

OB4: to review other non-technical factors such as cultural and organisational developments etc. and the theories and concepts behind that would need to be considered in managing the changes imposed from BIM implementations;

OB5: to find out how could the industry be able to have improvements with BIM adoption.

[#] While barriers would influence the implementation of changes for BIM (Building Information Modelling) adoption, upon further development of the research, it is considered that for comprehensiveness, non-barriers issues should also be addressed. The term "factor" is thus used to replace this term and the updated objectives OB1 and OB2 are revised to the following:

OB1: to review and identify the underlying **factors** in BIM implementation that have been in existence and still exist, and those newly arisen after the mandate of BIM use by the Hong Kong Government;

OB2: to review and evaluate the rationale behind of the existences and the impacts of such **factors** on the BIM implementation processes;

The interview questions are set to facilitate achievements of these objectives. The list of these objectives together with the links with the research questions as approved in the PAP, are summarised in the list below:

Related Research questions (as in the approved PAP)	Objective/ answers to be obtained	Interview Questions
(Background information)		2.1 May I know about your overall major role in the organisation you are working with/ institution you are representing?
		2.2 May I know what are the objectives and plan of your organisation / institution in BIM usage?
		2.3 May I know your role or assigned responsibility in BIM adoption??
		As stated in the BIM Adoption Survey 2019 issued by the Hong Kong Construction Industry Council, users are be categorised BIM Leaders, BIM Adopters and BIM Laggers. (Hong Kong SAR Construction Industry Council, 2019) In line with the report contents, each of these categories might be defined as follows: • BIM Leaders: users that on average use BIM in more than 80% of their projects / works • BIM Adopters: those who have used BIM but not so extensive as BIM Leaders

Related Research questions (as in the approved PAP)	Objective/ answers to be obtained	Interview Questions	
		• BIM Laggers: those who has not heard of BIM or does not have active BIM projects	
		2.4 A. Which of the above category would you select to best describe your organisation in terms of BIM adoption? 2.4 B. Which of it would best describe yourself?	
		(Questions 2.5 to 2.25 would be asked based on answer given in 2.4A for the organisation first. After that the same set of questions would be asked again based on the answer given in 2.4B for the interviewee.)	
		For BIM leaders and Adopters:	*For BIM Laggers:*
		2.5 What would be the approximate average percentage of the projects/ works using BIM?	
RQ1: What are the benefits and barriers imposing upward driving and downward pressing forces respectively in BIM implementation in the construction industry?	OB1	2.6 In the past, what have been the major factors that have driven/ helped your organisation/ you to change to adopt BIM?	2.12 In the past, what have been the major factors that have stopped your organisation / you to change to adopt BIM?
RQ2: How each of them is driving up or pressing down the path for implementation?	OB2	2.7 In what ways these factors have helped in implementing the changes?	2.13 In what ways these factors have stopped in implementing the changes?
RQ3: Why they have such influencing power?	OB2	2.8 Comparatively, what are the factor(s) that have the most	2.14 Comparatively, what are the factor(s) have the most restraining force for

Related Research questions (as in the approved PAP)	Objective/ answers to be obtained	Interview Questions	
		driving/helping force for making the change?	not making the change?
		2.9 Why do you consider so?	2.15 Why do you consider so?
RQ4: What are the relationships between them?	OB2	2.10 Conversely what are the factors that have stopped you from the change implementation?	2.16 Conversely what have been the factors that might have driven/ helped you to implement the change?
RQ5: What are the net resulting driving up/ pressing down force?	OB2	2.11 Eventually how have them been overcome?	2.17 Why eventually they are not successful?
	OB2	2.18 In future, what are your anticipated factors that that would either have positive or negative effects on the BIM adoption processes?	
RQ6: Could such net remaining force be determined and improved	OB3	2.19 How would they affect the adoption processes?	
		2.20 How should these factors be managed to achieve better results?	
		(the following two questions will be asked only if technological factors are covered in the above)	
		2.21 Besides the technological issues, what are the non-technological factors that need to be considered and handled in managing the changes imposed by the BIM implementations?	
		2.22 How have they affected the BIM adoption?	
RQ7: Besides the technological issues, what are the other factors that need to be considered and handled in managing the changes imposed by the BIM implementations?	OB4	2.23 For the above mentioned factors, what do you think are the effects imposed by the Hong Kong Government's mandate on the use of BIM for her projects?	

Related Research questions (as in the approved PAP)	Objective/ answers to be obtained	Interview Questions
RQ8: How has, or how would the mandate on BIM adoption affect these forces?	OB1	2.24 How have these factors been affected?
RQ9: Have the upward forces been strengthen and the pressing down forces be weakened, or the vice versa?	OB1	2.25 How could the effects from the mandate be managed in order to maximise their strength in driving/ helping implementation of the change in BIM adoption?
RQ10: Have the other factors been affected?	OB1	(covered in RQ8 and RQ9)

For objective OB5 - "to find out how the industry could manage to have improvements with BIM adoption": this would be achieved by the analysis above, supplemented with my own comments/ input, and completion of the other parts of the research project.

To facilitate running of the interview, an interview guide covering the preliminary questions, briefing and list of the above interview questions had also been forwarded to each participant before the meeting. A master copy of it is attached in Appendix 11 : *Master copy of Interview Guide*.

4.11 Interview Findings - The Interviewees Characteristics

As mentioned earlier, the interviews were intended to obtain advice from the interviewees on factors/issues that need to be considered based on their involvement, experience, and foresights. All the interviewees have shown their generosity by not just answered the interview questions but also raised their own views and suggestions for the research project. The following are records of the processes and summary of the findings.

4.11.1 The Interviewees' Major Responsibilities

As mentioned above, the 12 interviewees come from different organisations of 6 different sectors. In accordance with their major responsibilities in the organisations in terms of change implementation, they could be grouped under the following three categories:

Directorial: at directorate level - making decision and/or taking lead on changes to be implemented

Managerial: at senior managerial level - managing the change implementations with appropriate sectors of the organisation or disciplines of the construction industry

Executional: at execution level - responsible for managing and/or carrying out of the works for implementing the changes

From their responses, it could be observed that individually, each of them has his distinct view, level of aspiration and ultimate targets to be achieved for the changes for adopting BIM (Building Information Modelling) implementation. They have been facing diverse driving and restraining forces of different magnitudes, with varied level of influences imposed by the nature of business, mission and approaches adopted by the organisations.

Besides their position in the organisation, it is also worthwhile, if not essential, to know the characteristics of these interviewees as these would very much relate to their views and comments. For development of the Change Management Framework, this would be one of the many issues that have to be looked into in order to implement changes effectively.

So, there are a handful of characteristics to be looked into and reported as there are many different aspects involved. After due consideration, the following three major areas would be encapsulated and the rationale behind are as follows:

4.11.2 The Interviewees' General Attitude

The general attitude, manner or behaviour towards adoption of BIM might not be expressively indicated but might be observed from the interviewees' expressions and reactions when discussing this issue. This kind of characteristics, in general would be in line with the interviewee's unconscious or subconscious mind with a lot of theory behind. However, the details would be far beyond the scope of this paper, so only the general feelings and overall views of their attitude etc would be reported, with the objective to give an indication on what have been observed about them with regard to change implementation.

After reviewing of the interviewees' responses etc, collectively it is found that their attitudes for implementing changes for BIM adoption could be classified under the following four types:

- Conservative: having reservations in implementing changes
- Anxious: understand that changes have to be implemented but still have worries, nervousness, or unease about the change implementation
- Determined: having the will to implement the changes
- Enthusiastic: Having intense and eager interest, lots of self-motivation for implementing the change, will undertake and/or insist such implementation even not being requested or being opposed from doing so

4.11.3 The Change Adoption Status of the Interviewees

The next aspect of the interviewees to be described would be their current status in terms of change adoption. The status, with the associated explanations, as illustrated in the Change Adoption Curve (Change Management Solutions Canada, 2021) below is considered to be most appropriate for use in this research project for describing the status of the interviewees:

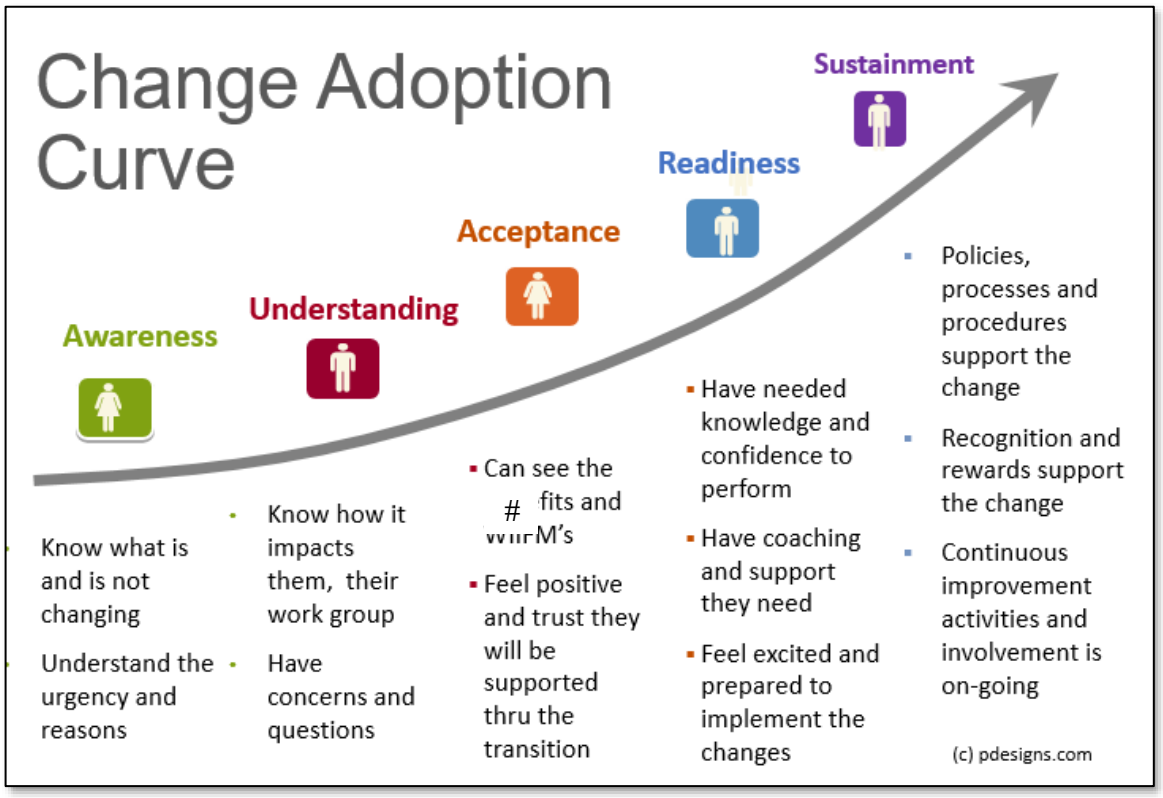


Figure 4-1 Change Adoption Curve

(#note: WIIFM is the abbreviation of "What is it for me?")

In adopting technological changes, people would experience various stages of changes in knowledge of the aspect. Some of them might go through all the stages relatively quick, whilst some would be slow and would not proceed at all. This kind of status would have much impact on the driving or restraining forces that the person would exercise on implementing the changes.

4.11.4 The Interviewee's Roles in implementing change

As explained by Al-Alawi *et al.* (2019), the five elements in the ADKAR model and the change achievements are as follow:

- **A**wareness *of the need to change*;
- **D**esire *to participate and support the change*;
- **K**nowledge *of how to change (and what the change looks like);*
- **A**bility *to implement the change on a day-to-day basis;* and
- **R**einforcement *to keep the change in place.*
  (Al-Alawi *et al.*, 2019)

While it is said that the ADKAR Model of Change Management "*is an outcome-oriented change management method that aims to limit resistance to organizational change*" (*What Is ADKAR Model for Change Management?*, 2019), the five elements of the model are considered as appropriate for being used as the headings for categorising the interviewees' roles in implementing changes in the organisation for adopting BIM. This means that only the names of the elements are used but not the meanings differ.

For this paper, the interviewee's roles are categorised under the five element headings as follow:

> **Awareness**: interviewees under this category have the knowledge in the changes to be adopted;
>
> **Understanding**: for interviewees who know about the impacts of the changes to be adopted;
>
> **Acceptance**: for interviewees who understand the benefits of adopting the changes;
>
> **Readiness**: for interviewees who have all the necessary knowledge and confidence to adopt the changes;
>
> *(note: interviewees in the above four categories, even those with the "readiness" status, are those who have not yet implemented the changes)*
>
> **Sustainment:** for interviewees who have adopted and set up policies or in the process of implementing the changes

The term "awareness" used here is the same with the one used in the Change Adoption Status. However, these two terms are different in the sense that in the Change Adoption Status, it refers to the interviewee's knowledge status of the person himself, while in the Roles in Implementing Change, it refers to the interviewee's awareness of the need to implement the changes by the organisation.

Based on the above, the characteristics of each of the interviewees have been observed. The observations are summarised in the session below, with the objective to let the readers have an overall understanding of each of them, in respect to change implementation.

4.11.5 Observation Summaries and Analysis – Terms and Notes

Quite a number of terms and definitions have been used or developed during the analysis process and compilation of the observations. To enable better understanding of them, definitions and notes on the terms used in the summaries of observations and analysis are summarised in the table below.

Terms	Definitions/ Notes
General Attitude	In line with the Longman Dictionary of Contemporary English, "attitude" is defined as *"the opinions and feelings that you usually have about something, especially when this is shown in your behaviour"*.

	For this paper, the term "General Attribute" refers to the interviewee's manner or behaviour towards BIM adoption.
General Attitude – classifications	The following are the four types of General Attribute, derived from reviews of the interviewees' responses given in the interviews conducted: • **Conservative**: refer to interviewees who have shown reservations in implementing changes for adopting BIM; • **Anxious**: refer to those who have shown their understanding about the need for implementing changes for adoption of BIM, but have worries, nervousness, or unease about the change implementation; • **Determined**: refer to those having the will or at the stage of being obliged to implement the changes for BIM adoption; • **Enthusiastic**: refer to those who have intense and eager interest, much self-motivation for implementing the change for adopting BIM, showing that they will undertake and/or insist for such implementation even not being requested or being opposed from doing so
Change Adoption Status	For this paper, the term "Change Adoption Status" refer to the interviewees' status, mainly in terms of their knowledge in changes for BIM implementation.
Change Adoption Status - categories	The categorising approach mainly follows the status categories set out in the Change Adoption Curve developed by a network of experienced change management professionals (Change Management Solutions Canada, 2021) as described in paragraph 4.11.3. The following are the five categories used to describe the interviewees' status in adopting changes for BIM implementation: **Awareness**: interviewees under this category have the knowledge in the changes to be adopted; **Understanding**: for interviewees who know about the impacts of the changes to be adopted; **Acceptance**: for interviewees who see the benefits of adopting the changes; **Readiness**: for interviewees who have all the necessary knowledge and confidence to adopt the changes; *(interviewees in the above four categories, even those with the "readiness" status, have not yet implemented the changes)*

	Sustainment: for interviewees who have adopted and set up policies or in the process of implementing the changes
Roles in Implementing Change	In line with the Longman Dictionary of Contemporary English, the term "role" is defined as "*the way in which someone or something is involved in an activity or situation, and how much influence they have on it*". For this paper, the term "Roles in Implementing Change" refers to the ways that the interviewees are involved in the activities in change implementation for BIM implementation.
Roles in Implementing Change - categories	The names of the five elements in the ADKAR model is used as the category headings for the Roles in Implementing Change. However, the definition of the roles here would not be the same as the original meaning of those in the ADKAR model. The five categories used to describe the interviewees' roles are as follows: • **A**wareness: interviewees under this category are aware of the need and/or reasons for the organisations to adopt the changes, but are not yet involved, or not in a position to be involved in the change implementation; • **D**esire: interviewees who desire to implement the change and have participated and/or supported the change implementations; • **K**nowledge: interviewees who have the knowledge in what and how to change, and are involved in the provision of training or coaching for the change implementations; • **A**bility: interviewees who have the ability and are involved in implementing the changes; • **R**einforcement: interviewees who are monitoring and reinforcing the changes to ensure that they are implemented to achieve the targeted outcome.
Level	A numeric level is assigned to e ach of the groups of interviewees in the categories listed above. The assigned level refers to the group's impact strength on change. The total number of levels assigned is the same as the number of groups in the appropriate category. Groups with the highest impact or influence level, etc., would be assigned with a level with the largest number. For example, for a category with 5 groups, the total number of levels would be 5. Level 5 would be assigned to the group with the largest impact strength.

	The objective of assigning numeric levels is to provide a distinctive and clear indication of the position or status, etc. of each of the groups in the particular category. These numeric levels would also facilitate analysis for revealing the relationships amongst the groups in other categories. More details could be found in Chapter 4, paragraphs 4.11.7 and 4.11.8. Below are descriptions of the levels assigned and the approach adopted.
Responsibility Level for "Major Responsibilities" Category	The "Responsibility level" in this Category refers to the level of influence by the group in implementing the changes. Given there are only 3 groups, (1) Directorial, (2) Managerial and (3) Executive, a total of 3 levels are assigned to the groups. The highest "Level 3" is assigned to the "Directorial" group as people in this group would have relatively high influence over change implementation than the other two groups. Conversely, since the executive group is responsible for managing and/or carrying out of the works for change implementation, its level of influence would be relatively lower than the other two. So, the lowest "Level 1" is therefore assigned to them. The "Managerial" group is then assigned with the level in the middle, i.e. "Level 2".
Attitude Level for the "General Attitude" Category	In this Category, there are 4 groups, namely (1) Conservative, (2) Anxious, (3) Determined and (4) Enthusiastic. In line with the approach described above, the highest "Level 4" is assigned to the "Enthusiastic" group because people in this group would impose the highest driving force in change implementations. In line with the driving force level, the levels are assigned to the other three groups as follows: Level 1: Conservative Level 2: Anxious Level 3: Determined
Adoption Level for the "Change Adoption Status" Category	The levels assigned to the groups in this Category follow the sequence of the status in Change Adoption Curve as follows: Level 1: Awareness (the lowest level) Level 2: Understanding Level 3: Acceptance Level 4: Readiness

	Level 5: Sustainment (the highest level)
Role Level for the "Roles in Implementing Change"	The levels assigned to the groups in this Category follow the sequence of the elements in the ADKAR Model as follow: Level 1: Awareness (the lowest level) Level 2: Desire Level 3: Knowledge Level 4: Ability Level 5: Reinforcement (the highest level)

Below are the analysis and summaries of the observations of the interviewees' characteristics.

4.11.6 The Interviewees Characteristics – Summary and Initial Analysis

The table below is a summary of the major responsibilities and the three types of characteristics of all the twelve interviewees. In order to avoid any possible matching of the identity of each of the interviewees with such descriptions, the PIS (Participant Identification Number) of the interviewees are not shown. Instead, a Ref No. (Reference Number) is assigned to each of them. These Ref No. are assigned to each of the interviewees in a random pattern without any relationships to their position or other aspects. (A full version of this table with details of the interviewees, however, has been submitted to the University Supervisor for necessary refence.)

Ref No.	Major Responsibilities Category	The General Attitude	The Change Adoption Status	The Roles in Implementing Change
1	Directorial	Enthusiastic	Sustainment	Reinforcement
2	Directorial	Determined	Readiness	Knowledge
3	Directorial	Enthusiastic	Sustainment	Reinforcement
4	Executive	Enthusiastic	Sustainment	Reinforcement
5	Managerial	Enthusiastic	Readiness	Knowledge
6	Managerial	Enthusiastic	Sustainment	Reinforcement
7	Managerial	Conservative	Understanding	Awareness
8	Executive	Conservative	Awareness	Awareness
9	Managerial	Determined	Understanding	Desire
10	Directorial	Anxious	Awareness	Awareness
11	Executive	Enthusiastic	Sustainment	Reinforcement
12	Executive	Determined	Readiness	Knowledge

Table 4-5 Major Responsibilities Category and Characteristics of Interviewees

4.11.7 Initial Review on Indication of Relationship between Responsibilities and Characteristics

To facilitate reviews and analyses of the characteristics etc, the above data are structured as an Excel table, with each type of responsibilities and characteristics added with the relevant "strength level". The strength level refers to the likely impact on change implementations imposed from such responsibilities or characteristics. Those with higher impact or influence would be assigned with a higher level.

As an example, for the "Major Responsibilities" column, there are only 3 categories only. Since interviewees at Directorial level would have higher influence power in implementing the changes. the highest level "3" is assigned to them.

Similarly, as there are 4 types of "General Attitude", the highest level of "4" would be assigned to those who are observed as "Enthusiastic". Each of the "Change Adoption Status" and "Roles in Implementing Change" have 5 different scoring, and the highest level of "5" assigned to both "Sustainment" and "Reinforcement".

The table added with these levels is as below:

Ref No.	Major Responsibilities Category	Responsibility level	The General Attitude	Attitude Level	The Change Adoption Status	Adoption Level	The Roles in Implementing Change	Role Level
1	Directorial	3	Enthusiastic	4	Sustainment	5	Reinforcement	5
2	Directorial	3	Determined	3	Readiness	4	Desire	2
3	Directorial	3	Enthusiastic	4	Sustainment	5	Reinforcement	5
4	Executional	1	Enthusiastic	4	Sustainment	5	Reinforcement	5
5	Managerial	2	Enthusiastic	4	Readiness	4	Desire	2
6	Managerial	2	Enthusiastic	4	Sustainment	5	Reinforcement	5
7	Managerial	2	Conservative	1	Understanding	2	Awareness	1
8	Executional	1	Conservative	1	Awareness	1	Awareness	1
9	Managerial	2	Determined	3	Understanding	2	Desire	2
10	Directorial	3	Anxious	2	Awareness	1	Awareness	1
11	Executional	1	Enthusiastic	4	Sustainment	5	Reinforcement	5
12	Executional	1	Determined	3	Readiness	4	Knowledge	3

Table 4-6 Responsibilities and Characteristics with respective influence levels

The level assigned would give a clearer indication of the position or status, etc. of the groups. Also, it would also facilitate the analysis to reveal the relationships amongst the groups. However, these levels are on relative scales only but not based on any science calculations. They should be used as indicative levels or for comparisons purpose only.

As the first attempt, the table is sorted under the "Major Responsibilities Category" in descending order of their respective scores. The outcome is as below:

Ref No.	Major Responsibilities Category	Responsibility level	The General Attitude	Attitude Level	The Change Adoption Status	Adoption Level	The Roles in Implementing Change	Role Level
10	Directorial	3	Anxious	2	Awareness	1	Awareness	1
3	Directorial	3	Enthusiastic	4	Sustainment	5	Reinforcement	5
2	Directorial	3	Determined	3	Readiness	4	Knowledge	3
1	Directorial	3	Enthusiastic	4	Sustainment	5	Reinforcement	5
9	Managerial	2	Determined	3	Understanding	2	Desire	2
7	Managerial	2	Conservative	1	Understanding	2	Awareness	1
6	Managerial	2	Enthusiastic	4	Sustainment	5	Reinforcement	5
5	Managerial	2	Enthusiastic	4	Readiness	4	Knowledge	3
12	Executional	1	Determined	3	Readiness	4	Knowledge	3
11	Executional	1	Enthusiastic	4	Sustainment	5	Reinforcement	5
8	Executional	1	Conservative	1	Awareness	1	Awareness	1
4	Executional	1	Enthusiastic	4	Sustainment	5	Reinforcement	5

Table 4-7 Table with sorted Major Responsibility Category

As an initial indication, it could be observed from the above table, there is no direct relationship between the Major Responsibility Category and their individual "General Attitude". As an example, for Directorial level interviewees (Ref No. 3 and 1 in the above table), both of them are at Directorial level and have the same characteristics, i.e. an enthusiastic attitude, at sustainment adoption status, and reinforcement roles. However, the other two Directorial level interviewees (Ref No. 10 and 2) do not have the same attitude. One of them (Ref No. 2) is "determined" and the other one (Ref No. 10) is "anxious". The reason behind might be that each of them are also being influenced by their organisations' vision and mission. As a result, even these people are at the Directorial levels, not all of them are in the position to implement the changes for adopting BIM in full strength as they have to review and follow with the organisation strategy, resources, alternatives and options available etc.

4.11.8 Further review on other relationships

The next attempt is to have the interviewees be sorted in accordance with their General Attitude level as in the table below:

Ref No.	Major Responsibilities Category	Responsibility level	The General Attitude	Attitude Level	The Change Adoption Status	Adoption Level	The Roles in Implementing Change	Role Level
1	Directorial	3	Enthusiastic	4	Sustainment	5	Reinforcement	5
3	Directorial	3	Enthusiastic	4	Sustainment	5	Reinforcement	5
5	Managerial	2	Enthusiastic	4	Readiness	4	Desire	2
6	Managerial	2	Enthusiastic	4	Sustainment	5	Reinforcement	5
4	Executional	1	Enthusiastic	4	Sustainment	5	Reinforcement	5
11	Executional	1	Enthusiastic	4	Sustainment	5	Reinforcement	5
2	Directorial	3	Determined	3	Readiness	4	Desire	2
9	Managerial	2	Determined	3	Understanding	2	Desire	2
12	Executional	1	Determined	3	Readiness	4	Knowledge	3
10	Directorial	3	Anxious	2	Awareness	1	Awareness	1
7	Managerial	2	Conservative	1	Understanding	2	Awareness	1
8	Executional	1	Conservative	1	Awareness	1	Awareness	1

Table 4-8 Table sorted in General Attitude Level

The results are quite clear that interviewees with higher level of General Attitude would be at a higher level in the Change Adoption Status, and also have relatively higher level or Roles in implementing the changes. The major exception is interviewee (Ref No. 5) whose General Attitude is at the highest Level 4, he does not fall within the Level 5 of "Reinforcement" yet and stays at Level 2 of "Desire" only. This is mainly that a majority of the works of his organisation are being carried out in the traditional mode without much advanced technology application. Relatively his role in change implementation becomes less significant.

Reflection: As a preliminary but important indication, it could be observed from the above that change implementation would very much depends on individuals' own attitude. While there are other associated factors such as their responsibilities, their adoption status and roles, comparatively the attitudes are the dominant ones, being something evolved or being derived from personal behaviours. In fact, this could be named as one of the most important sectors in change management. For any change implementation or any other issues, people are the utmost important element and their attitude would have the most influential effect. For effective change implementations, it should be ensured that all people involved are well equipped/educated to implement the change and are self-motivated strongly to implement the change. These factors are covered under "Willingness to change"; "Environment" and "Self-motivation" under the Locality Category in the Change Management Framework.

4.12 Interview Findings - Theme Analysis on Change Management

In general, the analysis processes have been done in accordance with the phases of thematic analysis as mentioned in 3.5 Analysis Process Framework. Below are the summary of the processes, findings and reflections.

4.12.1 Phase 0: Preparation of the transcripts for the interviewees' responses

The video and/or audio recordings of the interviews have been transcribed, usually within the same week after the interview. During the interviews, notes on major points raised by the interviewees were made. These notes are found to be very useful in facilitating the transcribing processes. In order to maintain the expressions and the tone of the responses, the wordings used by the interviewees were captured as far as possible without generalisation. The collating is done by means of the coding instead.

Ultimately, there is a total of 765 transcribed lines of the interviewees' responses. To facilitate the coding and theme searching processes, all these transcripts were input into an Excel file, with cross references to the source and the interview questions. A sample abstract showing the structure the transcripts is as below:

Ref	PIS	Q No.	Cat.	The Interview Questions/ Summary of Responses
13		**2.06**	**-**	**In the past, what have been the major factors that have driven/helped your organisation/ you to change and adopt BIM?**
41	AD601	2.06	A	Top management decision
42	AD601	2.06	A	Government policy
80	BC301	2.06	A	Government Policy
82	BC301	2.06	A	other factor: technology adopted by the construction sector
158	BE601	2.06	A	Increased market demand
44	AD601	2.06	B	self-motivation
84	BC301	2.06	B	development for smart cities
85	BC301	2.06	B	requirement for sustainability
86	BC301	2.06	B	requirement for carbon footprint reduction

Table 4-9 Sample Abstract showing the structure of transcripts

Legends

Ref.: the unique reference number assigned to each line of the transcripts

PIS: the reference number assigned to the interviewee on the Participant Information Sheet (PIS) and Consent Form

Q No.: the question number used in the Interviewee Guide (a copy is attached at Appendix 11 : *Master copy of Interview Guide*).

Cat.: the response category. (A) denotes that the response is related to the interviewee's organisation and (B) for those related to the interviewee himself. This is applicable to Interview Questions Q No. 7 to 25 only

In the sample above, the bolded first line is the interview question. The responses received from the interviewees are collated and listed under each of these questions to facilitate the coding exercises.

4.12.2 Phase 1: Familiarizing yourself with your data

At the outset, I have attempted to generate the initial codes directly from the transcribed data. However, after doing this for a while, I found that this could not work properly. The more the codes are established, the more I have the dazed feeling as I could not apprehend or even sense what could be done for the remaining transcripts. Eventually, I revert back to the "familiarising" processes again, i.e. "to read and re-read the data" to familiarize myself with it before initiating the coding exercise..

4.12.3 Phase 2: Generating initial codes

Even after the reading and re-reading exercise for familiarization, the code generation process is still a pain. Iterative processes have to be done forward and backwards to revise the codes in order to formulate in a systematic fashion. The time spent on this phase is considerably much more than what I have expected. For more than once, I did have the feeling that it would never be successfully completed. After several repeated occasions of having such unpleasant, or even hopeless feeling, I began to adopt the tactic in giving myself some cooling down time, stop the coding works, take breaks and review the other parts of the paper or draft the proposed structure of the Change Management Framework before resuming. This has proven to be useful as after that I could have a clearer mind and in particular, with the aid of the updated framework, some ambiguities in coding could be cleared as the directions for the way forward became clearer.

In establishing the initial codes, my aforementioned approach of identifying the "Subject Substance (SS) of "Change Factor" (Chapter 4, paragraph 4.4.2 : Literal Definition of Factor) has been followed, i.e. the data are analysed to identify what the "Subject Substance" is, in the hope of spotting what has caused the influence on the change in BIM adoption, and then use them as the interesting leads for further data collating.

As a recap, "Change factors" are defined as "*things that cause influence on and subsequently change something*". Change factors for adoption of BIM implementation would influence the adoption decision, process and outcome. The "Subject substance" is the "thing" that causes the influence.

After many rounds and rounds of review and revisions, finally a total of 21 theme codes have been established. They are listed in the table below in alphabetical order:

Ref No.	Theme Code (Subject Substance)
1	Community - External
2	Community - Local
3	Environment - Individual discipline
4	Environment - Individual organisation
5	Environment - Non-technological
6	Environment - Personal
7	Environment - Technological
8	Mission and Vision - Organisation
9	Requirements by Client and/or others
10	Resources availability - External
11	Resources availability - Internal
12	Road map - Organisational
13	Road map - Personal
14	Self-motivation - Personal
15	Sourcing strategy - In house
16	Sourcing strategy - Outsource
17	Target - Individual disciplines
18	Target - Individual organisation
19	Target - Personal
20	Willingness to change - Individual
21	Willingness to change - Organisational

Table 4-10 List of Theme Codes in Alphabetical Order

4.12.4 Explanatory notes on Theme Codes established

Below are some explanations and summary reports of the developments in establishing these Theme codes:

Community – External: these refer to the **external** parties, events, or substances etc. that would influence the change. The Subject Substances do not have direct working relationship with the

organisation or the personnel. Examples are the Hong Kong Government policy, its mandate for BIM adoption, the requirement for sustainability etc.

Community – Local: these refer to Subject Substances that have working or other direct relationship with the organisation or the personnel. Examples are demands from the industry, contractual requirements for the works, etc.

Environments: these refer to the situations, conditions etc. that might cause influences. Different codes are established in accordance with their nature, source or whereabout. They are treated as Subject Substances instead of Subject Attributes because themselves are the element imposing the influences. In this regard, "**Environment – Individual organisation**" and "Environment – **Personal**" refers to those within the interviewees' own organisations or individual interviewees. Those within the same discipline of the interviewee or organisation only would be coded as "**Environment – Individual discipline**", while those causing influence on also other disciplines, and/ or the entire construction industry would be coded separately under "**Environment – Technical**" or "**Environment - Non-technical**", where appropriate.

The other codes are rather self-explanatory but would be further elaborated later where required.

Not all interviewee's responses could be coded. It is because some of them are not directly related to change implementation processes. Finally, a total of 343 lines of transcripts has been coded. These codes are appended to each of the transcripts under the heading "Theme Codes (Factor Subject SS). Below is a sample abstract of the coded transcripts:

Ref	PIS	Q No.	Cat.	The Interview Questions/ Summary of Responses	Theme Codes (Factor - Subject Substance)
13		**2.06**	**-**	**In the past, what have been the major factors that have driven/ helped your organisation/you to change and adopt BIM?**	
41	AD601	2.06	A	top management decision	Environment – Individual organisation
42	AD601	2.06	A	government policy	Community - External
80	BC301	2.06	A	government Policy	Community - External
82	BC301	2.06	A	other factor: technology adopted by the construction sector	Community - Local
158	BE601	2.06	A	increased market demand	Community - Local
44	AD601	2.06	B	self-motivation	Self-motivation - Personal
84	BC301	2.06	B	developments for smart cities	Community - External
85	BC301	2.06	B	requirement for sustainability	Community - External
86	BC301	2.06	B	requirement for carbon footprint reduction	Community - External

Table 4-11 Sample Abstract of Coded Transcripts

4.12.5 Phase 3, 4 and 5 – Searching and Defining Themes

As there are a lot of iterative processes amongst Phase 3: Searching for themes, Phase 4: Reviewing Themes and Phase 5: Defining and naming themes. It is better to have them reported under the one heading.

All the coded transcripts are collated and listed under each of the theme codes, a full list of such coded and collated transcripts is attached in Appendix 10 : *List of Coded and Collated Transcripts* Below is a sample abstract of the list for one of the categories for explanation on its set up:

Theme Codes	**The Interview Responses (initial codes)**	**Cat .** *(Note 1)*	**Theme Codes counts** *(Note 2)*
Community - External	government policy	A	4

Theme Codes	The Interview Responses (initial codes)	Cat . *(Note 1)*	Theme Codes counts *(Note 2)*
	government policy on mandatory BIM usage	A	1
	developments for smart cities	B	1
	requirement for carbon footprint reduction	B	1
	……		
Community - External Total			37

Table 4-12 Sample abstract of listing of Coded and Collated Transcripts

Note 1 for "Cat.": For Interview questions 2.5 to 2.25, the interviewees were asked for responses on behalf of their organisations first and then spoke for himself. Responses given on behalf of organisations are coded as "A" and those personal responses are coded as "B".

Note 2 for "Theme Code Counts": these refer to the total number of identified themes codes. Below each of the categories, a sub-total of the code counts of the category are also listed.

As a start, with the aid of the Pivot Table function of Excel, the total number of transcripts that were coded under the same Theme Codes had been worked out. After that, the relative weighting, i.e., the percentage of total count, of each of them was then calculated and the list was sorted in descending order of the weighting. The objective of computing the weighting is to explore what would be indication of the relative importance level of each of the Subject Substance, based on the number of interviewees' responses. These weightings would serve as a reference only but would not be treated as any "benchmark" or "key indicator" for the coded themes. This is because different personnel or organisations may have diverse views, constraints, or targeted objectives etc. However, it is considered worthwhile to have such an index to be incorporated in the proposed Change Management Framework as an indication of the likely levels of weighting.

Below is the summary of the total count and relative weightings of the Theme Codes:

Theme Codes	Code Count	Relatively weighting
Community - External	37	11%
Environment - Technological	33	10%
Community - Local	30	9%
Environment - Personal	26	8%
Environment - Non-technological	24	7%

Theme Codes	Code Count	Relatively weighting
Target - Individual organisation	24	7%
Environment - Individual discipline	21	6%
Environment - Individual organisation	21	6%
Willingness to change - Individual	21	6%
Resources availability - Internal	19	6%
Self-motivation - Personal	19	6%
Resources availability - External	17	5%
Target - Personal	13	4%
Mission and Vision - Organisation	8	2%
Requirements by Client and/or others	7	2%
Sourcing Strategy - Outsource	5	1%
Willingness to change - Organisational	5	1%
Road map - Organisational	4	1%
Target - Individual disciplines	4	1%
Sourcing Strategy - In house	3	1%
Road map - Personal	2	1%
Total	**343**	100%

Table 4-13 Sorted summary of the total count and weightings of the Theme Codes

It could be observed from the table above that as a whole, most of the Subject Substance related to Community and Environment as each of them is having a weighting of 6% or more. Besides, the weightings of "Willingness to change – Individual", "Resources availability – Internal", and "Self-motivation – Personal", are also relatively high, at 6% each.

As a practitioner, the relative weighting of "Requirement by the Client and/or others", at 2% only, is surprisingly low. Based on my observations, most of the BIM models created for the project works are mainly for fulfilling the contractual requirements only but not for actual usage for the project works. In the BIM Adoption Survey in Hong Kong Report 2019, it is even concluded that this is a kind of "Compliance-drive mindset" that "*Organisations are primarily driven to adopt BIM to comply with client requirements*" (Hong Kong SAR Construction Industry Council, 2019, p. 5). The rationale behind would be that most interviewees are actual users, or at least are aiming for adopting BIM for actual use instead of meeting compliance requirements as outsiders. These initial codes and the data set would not be reviewed not only in relation with their individual

weighting but also due considerations have to be made to the possible variances of environment and requirements being faced by different people or organisations.

Moreover, these factors "would be changing rapidly, radically and unpredictably and will continue to do so" (Burnes, 2017, p. 384). A comprehensive list of such factors in details would not be possible, not owing to the time and resources constraint of this paper but not realistic. The practical approach would be to encapsulate the findings from primary or secondary research, supplemented with the researcher's own knowledge in the field, aiming at providing a structured framework, guiding and leading the Framework users to review and plan for appropriate actions. The "Emergent Approach" should be observed and applied where appropriate.

Reviewing, grouping, naming, revising of the theme code processes are iterative and very time-consuming. However, these exercises are not as discouraging as the initial code search. This is because at this stage, I am relatively more familiarised with the data, have more in depth understanding of the indications or intended meanings behind and more importantly, that the direction for further works has become clearer and thus there is less apprehension on what would be the next failure and a potential redo.

4.12.6 Phase 6: Producing the report

4.12.6.1 Theme Categories

Much in-depth thoughts and attention have been paid to the number of categories to be established for the Themes. As a matter of practicality, the number of categories should be limited, otherwise it would be too diversified without focus. On the other hand, if they are too clustered/generalised, coverage of each of the category would be too wide and not function well. After repeated reviews and amendments, finally it is considered that the most appropriate number of categories to be used is five.

With reference to the findings from the above and those from the literature reviews, theories studied reported in Chapter 2 and the findings from the primary research in Chapter 4 paragraph 744.5, supplemented with the researcher's own experience and knowledge in the industry requirements etc., a set of five categories of themes is established. They are:

1. Strategy
2. Locality
3. Affordability
4. Manageability
5. External Propensity

4.12.6.2 Categories of Theme Categories

Explanation of the coverage and developments of each of the Categorizations is as follows:

1. **Strategy**: this refers to the roadmap and intended movement for the changes to be implemented. This is listed as the first category because it has the most governing effect on change implementation. As an illustrating example, it could be commented that if there

is no strategy in implementing the change, then no single factor would be effective, let alone having any effect at all. The same outcome would happen if the strategy is set to be "not to change".

2. **Locality**: this is not referring to the physical location of the person or organisation, but the conditions of the personnel or organisation itself in terms of the readiness for implementing the change. For this scenario, not only the locality of the personnel himself but that of all people within the organisation needs to be considered. More elaboration on this would be covered in the session on CMF (Change Management Framework).

3. **Affordability**: literally, this would mean how much the person or organisation could afford to implement the change. However, I consider the opposing view as to how much they could afford "not to change" and that should be addressed as well. In fact, it would be comparatively more important. This is because at the outset, such "affordability for not to change" would determine the feasibility in implementing or completing the intended change. I have presented this concept in various conferences, seminars and lectures and have received appreciations. More details would be elaborated later, under 5.4 The Cultural Factors and the Influencing Force.

   The above also serves to explain that why "Affordability" is placed at a higher rank than Manageability, which has a relative higher code count (and in fact the highest) of 79 in the research.

4. **Manageability**: these refer to the Subject Substances that are mostly within the purview or under the controls by the individual person or the organisation. As indicated from high code counts, Subject Substances under this code would have the ultimate effect on the rate of success in change. However, while these are factors under control by the person or the organisation, they are also much influenced by the preceding three categories. As an example, as mentioned above, if the Strategy is not to implement the change, no matter what the conditions of the "Manageability" factors are, no change would be implemented, even if the level of Manageability is high.

5. **External Propensity**: this covers all the "external" Subject Substances that the person or organisation itself do not have much control but are having influences on the change implementations. These factors need to be constantly reviewed, analysed in order to reveal the changes in them for necessary adjustments to planning and actions for change implementations.

   (Note: in order not to create too much confusions to the users, in most of the cases, the commonly adopted term of "factor" is used in the Change Management Framework instead of "Subject Substances".)

Below is a summary of the Theme Category and the code counts for each of the Theme Codes and sub-codes:

Theme Category	Theme Code Count
1. Strategy	
Mission and Vision - Organisation	8
Road map - Organisational	4
Road map - Personal	2
Sourcing Strategy - In-house	3
Sourcing Strategy - Outsource	5
Target - Individual disciplines	4
Target - Individual organisation	24
Target - Personal	13
1. Strategy Total	**63**
2. Locality	
Environment - Personal	26
Self-motivation - Personal	19
Willingness to change - Individual	21
Willingness to change - Organisational	5
2. Locality Total	**71**
3. Affordability	
Resources availability - External	17
Resources availability - Internal	19
3. Affordability Total	**36**
4. Manageability	
Community - Local	30
Environment - Individual discipline	21
Environment - Individual organisation	21

Theme Category	Theme Code Count
Requirements by Client and/or others	7
4. Manageability Total	**79**
5. External Propensity	
Community - External	37
Environment - Non-technological	24
Environment - Technological	33
5. External Propensity Total	**94**
Total	**343**

Table 4-14 Summary of Theme Codes and Code Counts

4.12.7 The Power of Influence

From the results as shown in the table above, it could be noted that Category 5 - External Propensity has the highest number of theme code counts at 94. On the other hand, the total theme code counts for Category 3 – Affordability, at 36, is the lowest. This would indicate that as a whole, comparatively change factors in Category 5 have attracted more attention from the interviewees, indicating that factors under this Category have a relatively high power of influence on change implementation. Consideration on the difference in levels of such power are therefore required for effective planning for the changes and allocation of resources etc.

As an attempt to facilitate identification of levels of power of influence and application of necessary adjustments for the planning and resources allocations, numeric values of the relative strength of the power of each of the Categories, based on the theme code counts as mentioned above, are computed. As shown in Table 4-14 above, the theme code count for Category 3 - Affordability, at 36, is the lowest. It is therefore used as the base and being assigned the power percentage at 100%. Since the theme code counts of the other categories are comparatively higher, , it is implied that they have higher power of influence. The computed results are as follow:

	Total Theme Code Count	***Relative Influential Power***
Category 1 - Strategy	63	***89%***
Category 2 - Locality	71	***100%***
Category 3 - Affordability	36	***51%***
Category 4 - Manageability	79	***111%***
Category 5 - External Propensity	94	***132%***
Total	343	

The results above are based on the overall theme code counts. From the detailed breakdown of the theme code counts, it is observed that for interviewees of different responsibilities, the results would be different. The results for each Category of the interviewees are as follow:

	Theme Code Count				**Relative Influenctial Power**			
		by Major Responsibilities Category			(Based on Smallest Code Count = 100%)			
Theme Category	Overall	Directorial	Managerial	Executional	Overall	Directorial	Managerial	Executional
1. Strategy	63	27	23	13	175%	225%	288%	100%
2. Locality	71	32	20	19	197%	267%	250%	146%
3. Affordability	36	12	8	16	100%	100%	100%	123%
4. Manageability	79	26	21	32	219%	217%	263%	246%
5. External Propensity	94	20	40	34	261%	167%	500%	262%
Total	**343**	**117**	**112**	**114**				

Table 4-15 Relative Power of Influence

As an example, it could be observed while the theme code counts for Category 3 – Affordability by interviewees at Directorial and Managerial levels are both the lowest. However, for Directorial interviewees, their theme code counts for Category 2 - Locality, at 32, is the highest. Whilst for Managerial interviewees, the highest one is that for Category 5 - External Propensity, at 40. This indicates that each of these two categories of interviewees would have different level of concerns on the change factors. On the other hand, while the theme code counts for Category 5 - External Propensity factors are both the highest for the Managerial and Executional interviewees, the one with the lowest theme counts for Executional interviewees is Category 1 - Strategy, but not the same Category 3 Affordability with the Managerial interviewees.

The findings above indicate that people with different responsibilities would treat each of the change factors with different degrees of concerns. These have been considered and incorporated in preparing the Change Management Framework. The differences are presented in terms of percentages in the table at the right, based on the formula mentioned above. The table is incorporated in Framework to serve as references by the users for their consideration when making their own adjustments to the value of "Net Force Effects" for each of the Change Categories.

4.13 Reflection

No pain no gain. One of the "pains" is the very beginning of the research journey, with the big obstacle of comprehending and analysing the change factors. In this regard, the "gain" is the "Change Factor Analysis" that I have developed to overcome this pain. While I have said "*Fortunate enough, there was a breakthrough*", frankly speaking, I would not consider myself to be lucky only but diligent enough to locate solutions to relieve the pain so that I could further pursue my research.

By applying the Change Factory Analysis, I have been able to complete the Secondary Research processes satisfactorily, providing a rich description of the data set, thus enabling myself and readers to have a thorough understanding of the predominant and important elements about the factors to be considered in BIM implementation. With this milestone, I could proceed with the analysis of change factors based on visions and mission of organisations, and the interviews with experts. After that, I have also secured more "gains", although not always after "pain", from the analysis and interviews. All these "gains" have not only enabled further processes of the research work but also have made the research journey much more meaningful and enjoyable. Details of the "gains" and the findings and outcome of the project activity will be covered in the next Chapter.

Chapter 5 Project Findings and Outcome

5.1 Introduction

Up to this stage, the majority of the research processes, namely, literature review, secondary research and primary research, has been completed. As mentioned in the last chapter, the research findings, supplemented with the researcher's comment and input, have closely knitted relationships in iterative nature, with the criteria and backdrop of the Change Management Framework. Therefore, as a start, it is worthwhile to extrapolate such links and relationships between the various entities in a quick summary:

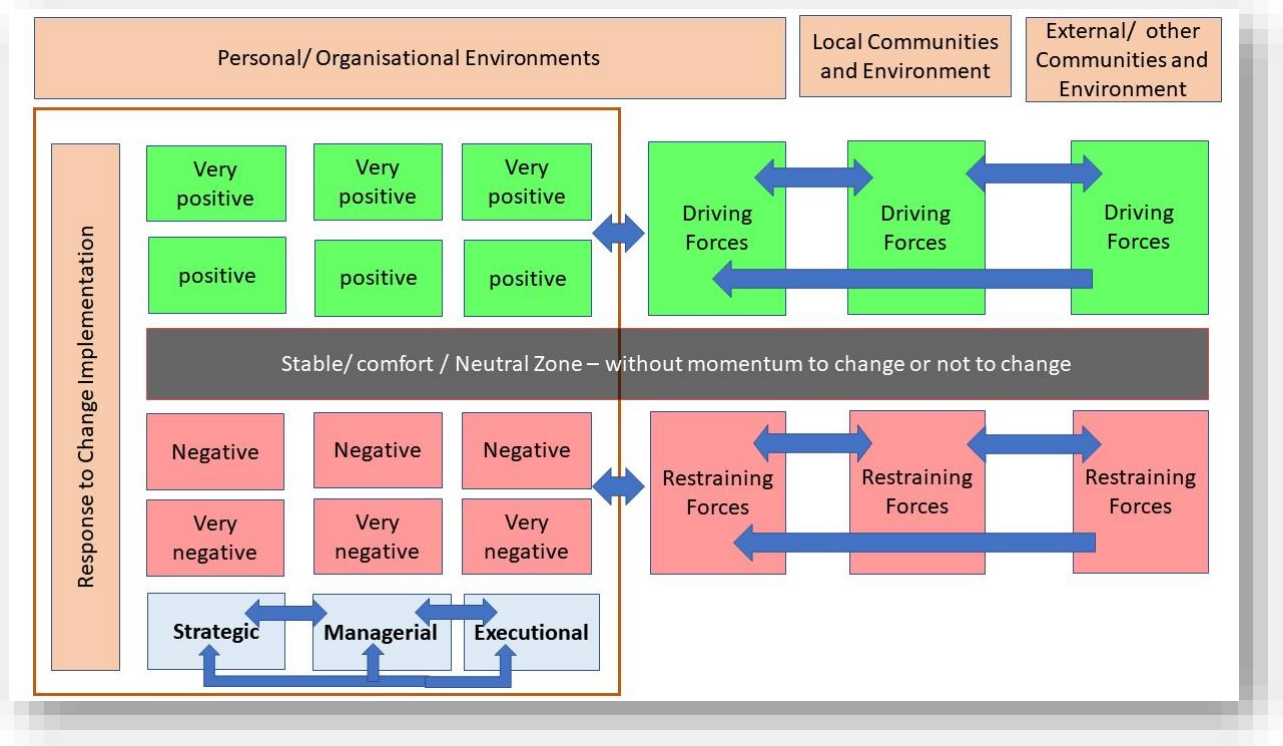


Figure 5-1 Interlink Relationship considerations

5.2 The Interlink Relationships

As explained in Chapter 4, paragraphs 4.4.3 Developed Definition and Composition of "Change Factor", the Subject Substance (SS) is exerting influence, but the extent of the influences, named in this paper as the "Influencing Power", would much depend of its "Attribute", i.e. its conditions, nature and status etc.

For changes in BIM implementation, many "Subject Substance" (SS) would be involved. However, most of them are not only there influencing the other Objects, but in fact at the same time are being influenced by others. As an example, for the construction industry, there are various organisations performing diversified functions and activities in the building lifecycle (reference Figure 3-1 BIM Uses throughout a Building Lifecycle in Chapter 3). For each of the individual organisations, there

are many employees doing different types of works with different responsibilities. Following the category of major responsibilities of such people used in Chapter 4, paragraph 4.11.1, these people are grouped under Directorial, Managerial and Executional.

The following sample cases would illustrate the likely outcome of the inter linking influence effects amongst each of these people.

Case 1: All the staff at the 3 different levels are all at the highest levels, that is, all of them possess enthusiasm, with their sustainment status at the change adoption curve, and already at Reinforcement role level for change implementation, as shown in the table below:

Major Responsibilities Category	The General Attitude	Attitude Level	The Change Adoption Status	Adoption Level	The Roles in Implementing Change	Role Level
Directorial	Enthusiastic	4	Sustainment	5	Reinforcement	5
Managerial	Enthusiastic	4	Sustainment	5	Reinforcement	5
Executional	Enthusiastic	4	Sustainment	5	Reinforcement	5

In this case, it could be said that the entire organisation is fully geared up and the change implementations would be efficient and effective. Each of the different categories of people are not hindering others when the change is under way.

Case 2: However, if it is the case that those at the Managerial levels are conservative, with both the change adoption status and implementation role at Awareness level only (as shown below), then the overall implementation efficiency and effectiveness is much lower.

Major Responsibilities Category	The General Attitude	Attitude Level	The Change Adoption Status	Adoption Level	The Roles in Implementing Change	Role Level
Directorial	Enthusiastic	4	Sustainment	5	Reinforcement	5
Managerial	Conservative	1	Awareness	1	Awareness	1
Executional	Enthusiastic	4	Sustainment	5	Reinforcement	5

The main reason for such is that strategic decisions or plans set up at the Directorial level have not been fully comprehended and cascaded to the Executional staff. While this may look like an exaggerated example, it could serve to demonstrate the resulting influence that might be imposed by one of the decision makers.

Case 3: Staff at the Managerial level are at a comparatively more enthusiastic than those in the earlier case. They are therefore in a better position to comprehend the strategies and cascade such

decisions to the Executional staff. However, the effectiveness and efficiency would not increase significantly if the staff at Executional level are not yet in the position to endorse and implement the changes, as shown below:

Major Responsibilities Category	The General Attitude	Attitude Level	The Change Adoption Status	Adoption Level	The Roles in Implementing Change	Role Level
Directorial	Enthusiastic	4	Sustainment	5	Reinforcement	5
Managerial	Determined	3	Readiness	4	Knowledge	3
Executional	Conservative	1	Awareness	1	Awareness	1

Summary: For any change implementation, people are always involved. In this regard, it might be concluded that the people factor is the most basic and the most crucial link in any change implementation. Their attitude, adoption status and role in change implementation must be at high level or otherwise the efficiency and effectiveness of change would not be significant. It would not be sufficient if only some of the people involved have achieved the required level. This is because any other people achieving a lower level would hinder or even ruin the planned developments. Out of all this, as indicated from the interview results, people's mindset and level of self-motivation in change implementation are considered to be vital and ought to be taken care of.

5.3 Change Mindset or Change People

Talking about people's mind set, before going to the other topic, I would like to share one of the advice given by Interviewee DO101 (at Directorial level). When we discussed the major factors affecting change implementation, he did agree that people's mindset was one of the major issues that ought to be considered. However, he further supplemented that he had never attempted to change people's mindset, as he would choose to change the arrangements of task delegation instead.

His reason is that it would be time consuming, resources demanding with high risk of failure in changing people who resist changes. So his view is that it is much more efficient and effective (in terms of achieving the desired results) to swap these people with someone who is having positive mindset to adopt changes instead of changing the formers' mindset or behaviour in implementing the changes.

Reflection: While this might one of the ways out, in practice it would not be applicable or feasible, in particular in those non-commercial organisations. Also, for large organisations, substantial change of personnel would be very costly, and also risky in terms of maintaining a stable business environment. However, this is one of the ideas, if not a solution, that the researcher has not thought of before. In accordance with the Change Factor definition as mentioned in Chapter 4, paragraph 4.4.3, originally the Change Factor is defined to have Subject Substance (SS), Subject Attribute (SA), Object Substance (OS) and Change on Object (OC), with the relationship stated as follows:

"Change Factors: the Subject Substance (SS) with Subject Attribute (SA) that cause

influence on and subsequently imposed change (OC) on Object Substance (OS)"

Based on the advice given by Interviewee DO101, the change factor would no longer be aiming at influencing an Object Substance, but swapping the Object Substance (People without the appropriate mindset) with a new Object Substance (People with the appropriate mindset) and therefore, the revised "definition" would be:

"Change Factors: the Subject Substance (SS) with Subject Attribute (SA)

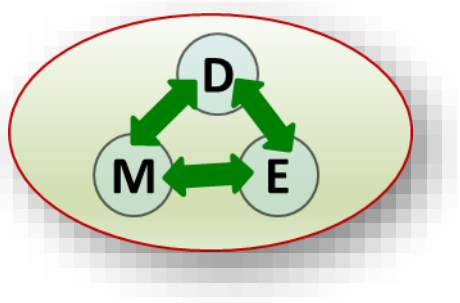
that change the Object Substance (OS) with a different attribute"

However, as stated above, this kind of "change" may not be applicable for all cases. Therefore, for this project, my original developed definition will still be used.

5.4 The Cultural Factors and the Influencing Force

People's mindsets, collectively, would be considered as the culture. As mentioned in Chapter 2, paragraph 2.4.1, each of the cultural factors in the Culture Knowledge Model would have interrelationship with many other factors. There would be large volume of varied cultural aspects regarding individual person, disciplines, organisation, local/ community and universal, with different factors and force magnitude etc. The possible complex matrix of such aspects and facts are illustrated in the diagram in Figure 2-10 : Cultural Factors Categories – In complex structure. It could be observed from this diagram that the Cultural factors do not exist independently but are interlinked with the others. Besides, these factors would be influencing each other with different linkage relationships and varied types of influences.

As this research project focuses on the driving and restraining forces being imposed on change implementations, only linkage relationship and influence related to BIM implementation would be covered. As a recap, peoples within an organisation and their individual standing and/or status would influence each other on BIM implementation, which could be illustrated in the diagram below:



Legend:

D = parties at Directorial level

M = parties at Managerial level

E = parties at Executional level

Figure 5-2 Influence relationship between parties within an organisation

Details of the responsibilities of each of the parties could be found in Chapter 4, paragraph 4.11: Interview Findings - The Interviewees Characteristics.

The arrows between them represents the direction of the influencing forces, with the arrowhead pointing at the parties being influenced. Since each of them is influencing each other, bi-directional arrows are used to represent the forces being imposed by each of them upon others.

Factors affecting the change implementation within the same organisation must be addressed carefully in order to achieve the targeted changes. However, factors outside the purview of the individual organisation need also be taken into account. As introduced in the Culture Knowledge Model (Chapter 2) there are several categories of knowledge cultures affecting change implementations and that change factors within each of these categories would be having interrelationships with the others. The complications of the interrelationships amongst the Cultural Factors Categories are illustrated in Figure 2-9 and Figure 2-10 in Chapter 2.

Figure 5-3 below is a compiled schematic diagram showing the interlinked relationships for the influencing forces between different categories of entities in the construction industry, similar to the pattern of knowledge categories as in Figure 2-9 Cultural Factors Categories.

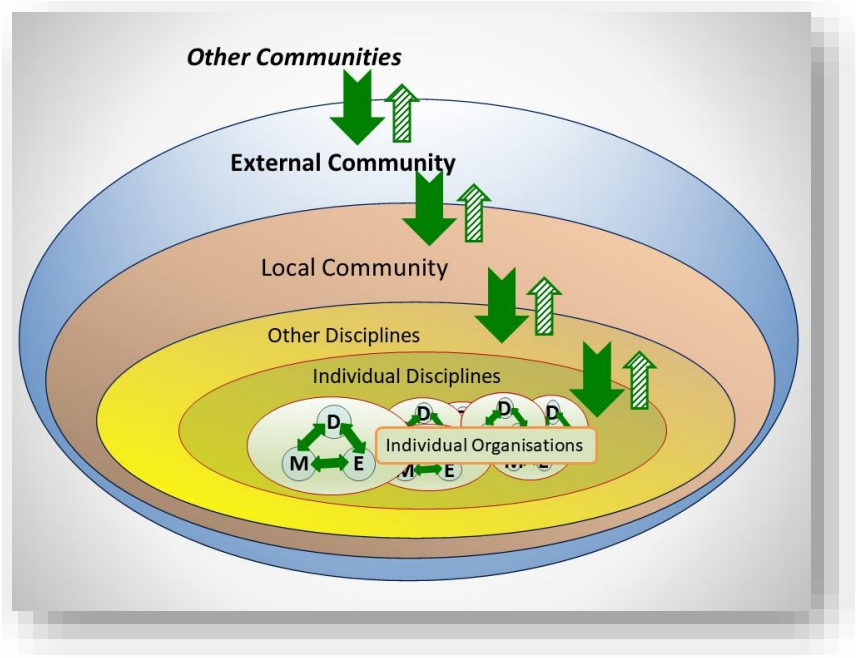


Figure 5-3 Influential Forces between Categories of organisations in the construction industry

Following the legend format used earlier, the arrows between the models are representing the influencing forces being imposed, with the arrow heads pointing to the Object Substance that are being influenced. Further to that, the relative magnitude of the influencing force indicated by the arrow size and infill format, as follows:

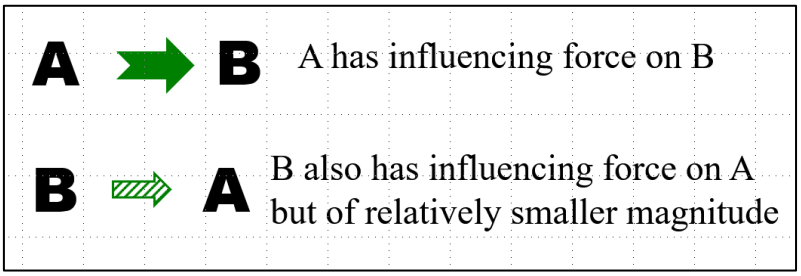


Figure 5-4 Legend for relative influencing force magnitude

Figure 5-5 below is an abstract showing the relationships between individual organisations and individual discipline.

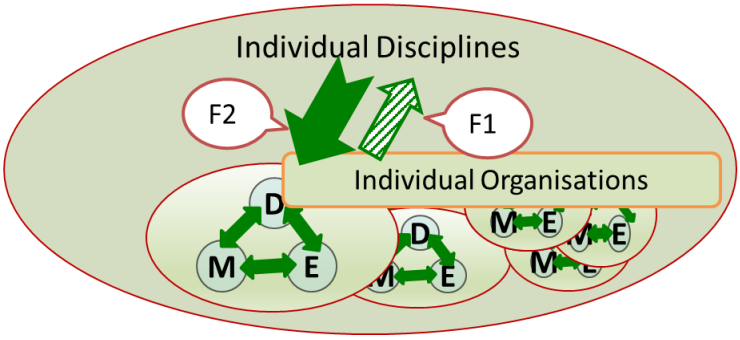


Figure 5-5 Relationships between individual organisations and individual discipline

The Individual Organisation's category covers organisations performing services in the same or similar disciplines, for example, project management, design consultants, or contractors etc. Change factors on BIM implementations might be similar or different for each of them. Change factors affecting the implementations within each of the organisations, would also have influence on others in the same discipline. For example, the higher the level of change adoption in the Change Adoption Curve (Figure 4-1) the organisation in the discipline is at, the more impactful it will be on other organisations in the same discipline. This is because their competitiveness would be lower if they still remain unchanged. This implies that there are certain influencing forces being imposed by the individual organisation modules on the individual disciplinary modules, represented by the arrow labelled with **"F1".** Conversely, after more and more organisations in the same discipline is at a high level of change adoption, in return, there would be influencing forces imposing on the individual organisations, in particular those still at a lower level.

The influencing force imposed by the individual disciplines is represented by the arrow labelled **"F2'.** In general, the degree of influencing power, that is the magnitude of the driving force, imposed by F2 would be comparatively higher than F1. These two kinds of forces F1 and F2 are represented in the legend format as mentioned in Figure 5-4 Legend for relative influencing force magnitude.

5.5 The complexity of the interrelationships

Similar to the forces being imposed between the individual organisations and individual disciplines, there are also forces between the following categories:

Individual Disciplines and Other Disciplines

Other Disciplines and Local Community

Local Community and External Community

External Community and Other Communities

The pattern and characters of the influencing forces between each of the above pairs of modules are similar to those explained for Figure 5-5 with arrows with the same legend format used to illustrate the force direction and magnitude.

However, as explained in Chapter 2, paragraph 2.4.1 The Culture Knowledge Model, in reality the interrelationships of each of the interrelationships amongst each of the categories would not be as simple or tidy as those shown in Figure 5-3. Instead, the relationship diagram might be much more complicated and look like the one in Figure 5-6.

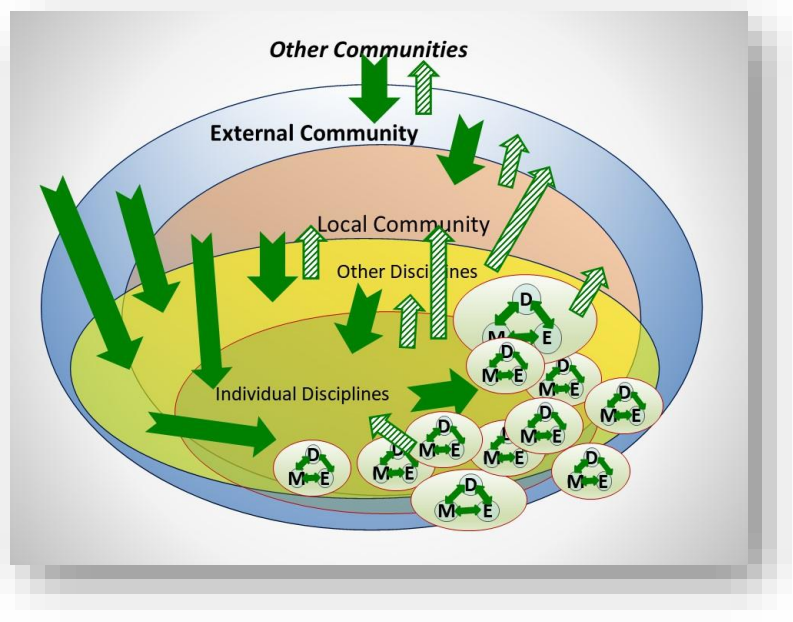


Figure 5-6 Complicated Influential Forces between Categories of organisations

5.6 Effect of Government Mandate on BIM Implementation

Government mandate for Building Information Modelling (BIM) adoption would be a good example illustrating the relationships with the "External Community". It is obvious that any policy set by the Government would influence a lot on the industry viz. the Local Community, the various disciplines, organisations and people in the industry. While the industry itself would also have influences on the Government's formulation of the policy, the former's impact value to the Government would be much smaller comparatively. Simply, the influence force imposed by the Government to the industry would be comparatively larger than that being imposed by the industry to the Government.

Regarding the force effect of the Government mandate on BIM implementation, the situation would be that if the mandate is implemented properly the driving force imposed would be substantial. However, resistances to such exerted force would be present. Those who are unwilling to change, afford not to change, or consider not changing is better than making a change, would find ways out to just showcase the BIM but not actually use it. In other words, they would just showcase whatever required by the mandate to meet the stipulated requirements and not execute it further. In this case, the actual benefits of BIM would not be achieved and this would further generate restraining forces to the industry for the changes for adoption. To conclude, it might be

said that half of the effect imposed by the mandate would be driving and the other half would be restraining.

The interesting point is that the 54 responses from the interviews regarding the effects of the government mandate, it is also found that nearly half of them (26) is positive, exerting driving force, while another half (28) concerns the negative, restraining force.

The comments supporting that the mandate is positive are:

- "the right mindset and skill set is created" (interviewee AD601);
- "without mandatory requirement, probably no one would start using BIM" (interviewee CR401), "the industry become aware of the drive, the need to must go and learn in using BIM: (interviewee DC101);
- "Forced the industry to try to use BIM. In fact it is good to have the try to see the results." (interviewee DS401);
- It would create "more cases, more exposures and increase interest in further pursing BIM" (interviewee BE601).

Conversely, some responses are commenting that while the mandate do initiate the use of BIM, in fact there are negative effects on the implementation processes, such as the following:

- it creates "the trend in outsourcing to outsiders in order to meet the requirements only" and as a result, "they are BIM doers only but not users" (interviewee BE601);
- it would lead to the "copying of requirements" into the tenders requesting the use of BIM while the actual requirements are not well understood by the contract parties (interviewee CR401);
- "there are different paces in different Government departments" thus restraining formulation of the targets (interviewee DC101);
- "the mandate only focuses on BIM technology but not fully on project works related tasks" (interviewee ED101);
- "the problem of inadequate training course will still be the problem to contractors and that they would tend to outsource the works instead of to learn and use BIM" (DS401).

The above indicates that there are different views on the Government mandate from different people. In fact, it could be observed from the above that some of the interviewees do have both positive and negative comments. This may be one of the reasons why the competing driving and restraining impacts resulting from the Government mandate as mentioned earlier is rational.

Reflection: In reality, the compositions of the organisations in the construction industry is complex and complicated. As a result, the interrelationship between organisations, and the pattern, nature, magnitude and effect of the influencing power amongst organisations would not be the same but dissimilar to each other. In this regard, establishment of a standardised measurement of the level of driving or restraining forces being imposed or received would not be feasible and in fact would not be realistic even if it is developed.

The above issue has been well considered in the development of the Change Management Framework as it would be used by different organisations or personnel, at different levels, with different responsibilities or status in adoption for the changes.

Other than the imposed influencing forces, the above would also explain partly the concept of "affordability for not to change" discussed in Chapter 4, paragraph 4.12.6.2. Further elaborations on this concept are covered below. This concept forms quite an important part in terms of influencing forces amongst each of the cultural models. As mentioned earlier, this concept has been presented in various conferences and received appreciations on its value in considering change adoption factors.

5.7 The "Affordability to change" and "Affordability NOT to change" concept

When considering the probability of successful achievement of a change implementation, one of the criteria is the "affordability" in doing so. However, the other factor, having even much more dominant effect on the decision, is the level of "affordability not to".

As commented by some of the conference audience as well as the interviewees, the concept behind is not difficult to understand but very often has not been considered thorough enough. The detailed explanation of the concept appears to be quite lengthy but are worthwhile for being considered in full. Altogether five cases, using figured examples, with different scenarios will be used to explain the concept.

Case 1: The price of a bottle of water is set at **HK$1 (around GPB0.1)**. For a person who has enough money in the pocket and feels thirsty, would very likely buy a bottle of water at this price. This constitutes a "change" from "having no access to water" to "having a bottle of water". For this case, it could be concluded that the chance for success in the change implementation is high or highly likely. Besides the fact there is a demand for change (the person is thirsty), the change could be successfully implemented because the person has got enough money and therefore can "afford to change". As shown in Figure 5-7 "Affordable to change" scenario, the person would be **in position A**, with the level of "Affordability to Change" at 100%, indicating that the chance for his success in change implementation (i.e. to "change" to have the bottle of water) would be in the "likely" region. However, the level of the affordability would decrease if the price of the water increases. When the price gradually increases to a price more than the money he has or he can afford, the level of affordability would become 0%, and the success in change implementation would become unlikely.

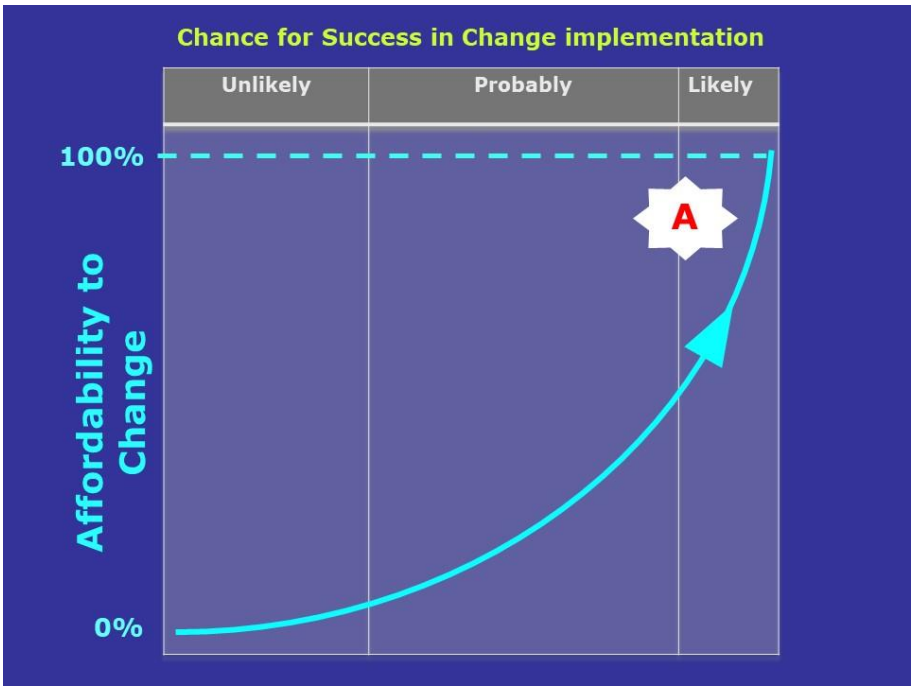


Figure 5-7 "Affordable to change" scenario

In Case 2, the bottle of water is priced at **HK$100 (GBP 10)** instead. While the person may still have enough money and affordable to pay for such, since the price is much higher than his anticipation, it may be less likely for him to buy the bottle of water. If it is at the time that the person is not feeling thirsty and that he foresees that soon he would be able to have water at a lower price or even free soon, the chance for buying the bottle would even become unlikely or zero. In this regard, the concept of "**Affordability not to change**" would apply. The success for change is affected by his "affordability not to change", i.e. he is in the **position B**, being very strong in terms of "affordable" **not** to make the change, as shown in Figure 5-8 "Affordable NOT to change" scenario. The chance for buying the bottle of water is slim regardless of his affordability to buy it.

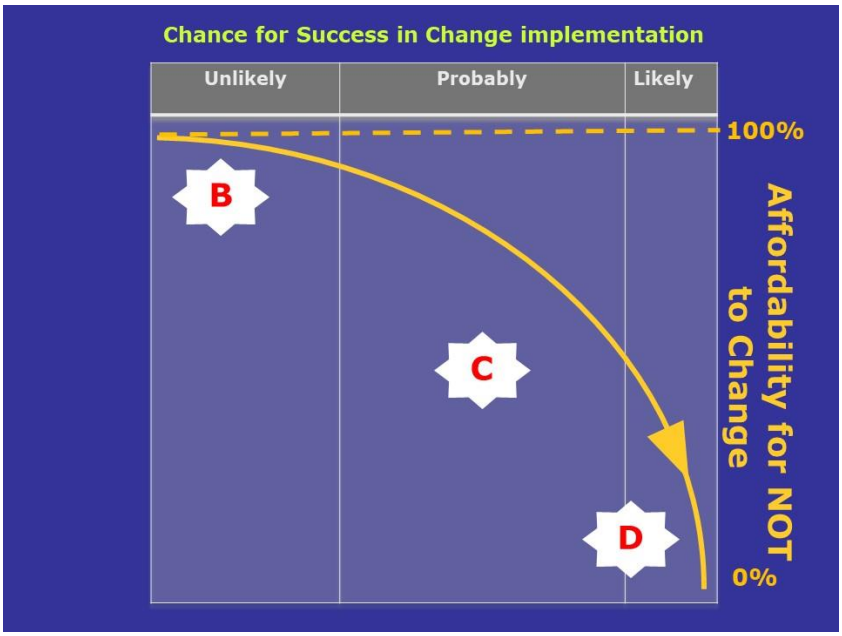


Figure 5-8 "Affordable NOT to change" scenario

Case 3 is that the person has not drunk water for a long time, feeling very thirsty and dehydrated very soon. In this scenario, his "affordability for not to change", or not to buy the bottle of water is weakened, the chance for him to buy the water at **HK$100 (**around **GBP 10)**, would become higher. He would be in **position C** instead and the chance for making the change would be relatively higher, being probable instead of unlikely.

Case 4 is that the person is now in a desert, having not drunk water for many days. He knows that he must drink some water or otherwise he would have health problem. In this case, his position would shift towards **position D**, as he cannot afford maintaining the status quo when compared with that in Case 2 or 3. The chance for him to buy the bottle of water would be much higher, and the chance for success in change implementation would become likely.

Case 5 is an exaggerated situation for illustrative purpose only. All the conditions are the same with Case 4 except that the bottle of water is disproportionately priced at **HK$1million (GBP 0.1 million)**. In this scenario, obviously not only the factor of "affordability not to change" would apply but also the "affordability to change" needs to be addressed. Whether or not the person would really pay such an amount to get the bottle could not be ascertained easily. For a poor person, he would not be able to buy it as this is totally out of his affordability. For an ordinary person, who may have just enough money, probably might not buy but rather to find another source of water at lower price. For billionaires, maybe he would not mind spending such an amount and buy it. The chance for success would therefore much depends on the willingness and behind the purview of affordability.

As a summary, the chance for success in implementing change would have to take into consideration of both aspects, the affordability to change and affordability not to change. Identification of the position of one's affordability needs to be made. For this, the question to be answered by anybody who want to make changes is his relative positioning as shown in Figure 5-9 below.

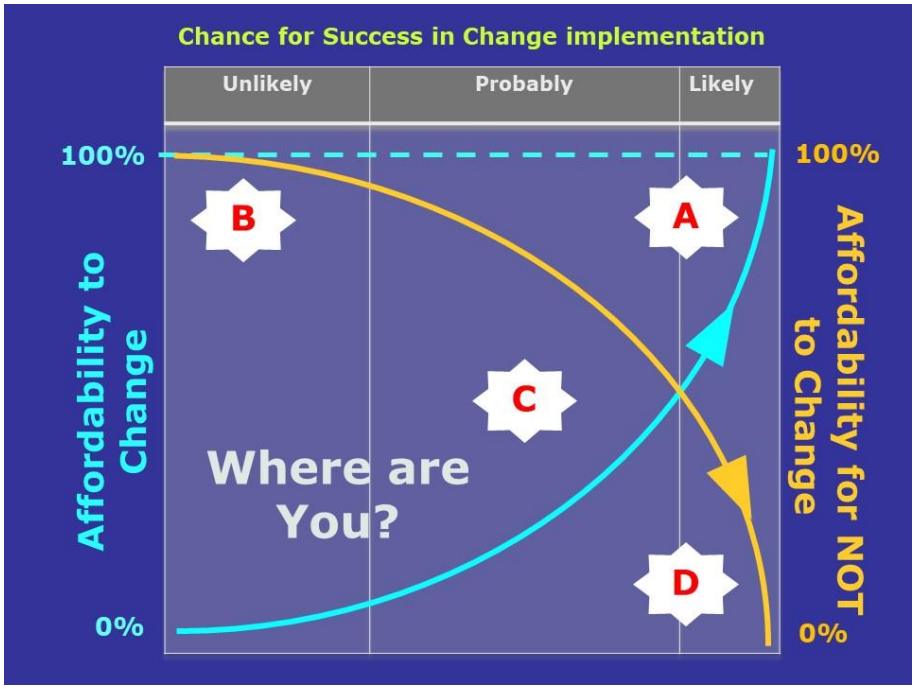


Figure 5-9 Summary of Affordability Scenarios

After identifying one's position for a particular change, the probability of success in implementing the change could be located. This would be an important area to be considered when planning actions to be taken, allocation of resources, etc. for effective change implementations.

While it could be argued that for the construction industry, adoption of BIM is a must and that every party in the industry would receive the benefits, the driving force for change implementation would be high and therefore the "affordable not to change" would not be substantial, the issue is that each party would have different levels of affordability to change and the one for not to. They ought to strike a balance to meet their own capabilities and establish the strategy for the change implementation base on such judgment. For this, in paragraph 5.8 below the researcher would like to quote another piece of advice obtained during the interviews on his view on BIM usage below. He raised the point that BIM should be perceived as a language, and this poses a factor for consideration in implementing the change in BIM adoption.

5.8 BIM to be perceived as a language

It is interviewee DC101 who points out that BIM should be treated as a language as it is used by different parties as the communication means for proceeding with the works for the construction industry. He pointed out that for effective application of BIM, it should be ensured that "*all parties are talking in the same language, aiming at the same target*".

The issue is that in the construction industry, there are many people involved and very often they have been using their own expertise, which are the practices and procedures in line with their disciplines. In this regard, they are using their own conventional language which has been considered to be most appropriate for use.

Regarding the "target", when ideally every party should aim at completion of the works in line with the specific time and quality, the focus of the target for each individual discipline may not always be the same.

As an illustration, the workflows in construction are described as a stream of water, with designers, consultants etc positioned at the upper stream, while the contractors and sub-contractors are at the lower stream. For traditional contracts, the designers, etc are the providers of information for the works and are of relatively higher status. For effective and efficient completion of their own tasks, naturally each of the designers would tend to limit to spend time and resources to provide information of the bare minimum only. On the other hand, contractors, etc. at relatively lower stream, however, have to rely on the information received from the designers at the upper stream before they could proceed further for their works. The contractors would therefore prefer having as much information as possible for the works to be carried out. In this case, it is not easy to judge and decide the load of information shall be provided as the targets of each of them, at different stream levels might not be matching with each other completely.

By using the term "language", we may say that for communications, the designers tend to use precise wordings or phrases of words to convey their essential ideas only, while the contractors would be expected to listen to lengthy sentences describing the entire story. To expand this language concept in BIM implementation in construction, the interviewee opined that while a common "language" needs to be established, it has not yet been in existence.

5.9 The Change Management Framework

5.9.1 Outline Descriptions of the Framework and "APDRA cycle"

As a recap, there are two issues that need to be address properly in setting up of the Change Management Framework, viz:

(a) complications of the interrelationships and
(b) difficulties in establishing standards for measuring the driving or restraining forces imposed

As the aim of the research project, the Change Management Framework is to be developed to conclude the results of the findings of the research, to have them supplemented with recommendations on the way forward. The target is to enable effective and efficient BIM implementation processes so as to achieve successful BIM implementation and maximise the potential benefits after adoption. Due to the complexity of the construction industry and the much varied nature, conditions or environments of organisations involved, the action plans to be adopted or implemented by different organisations or persons would also be complex and different.

As stated earlier in Chapter 4, paragraph 4.12.5, a practical approach supplemented with the researcher's own knowledge in the field, could be adopted to encapsulate the findings from the research, and then establish a structured framework for guiding and leading the framework users to review and plan for appropriate actions. In this regard, the proposed framework would mostly concentrate on the part on review and assessment, leaving the users to develop the appropriate action plans that they consider to be appropriate.

By using one of the commonly management methods used for improvement process, PDCA (plan–do–check–act, or plan–do–check–adjust) as an example, the Change Management Framework to be proposed would aim at providing a supplementary means for reviewing and assessing the overall conditions prior to establishing the plans for the improvements. Also, it would serve as the platform at the checking processes to reveal what have been achieved/not achieved so as to facilitate the forward action or adjustments. In this regard, the CMF would be positioned in the PDCA cycle as below:

Assess *(with CMF)* – ***P****lan* – ***D****o* – ***R****eassess* *(with CMF)* – ***A****ct/ Adjust*

This cycle would be named as the "**APDRA** cycle" and used in the research project works and the Change Management Framework.

Below is the structure of the Framework developed, supplemented with notes on the developments and explanations on what and how the issues as mentioned above have been considered and treated.

5.9.2 The Force Field Model Concept

The concept of Lewin's Change Model for Force Fields as described in paragraph 5.9 is used as the basis for development of the Change Management Framework. In the Framework, the targeted driving forces and restraining forces of the appropriate factors are assessed. The net result of the Forces would be computed to form the Target State of Forces.

Before planning the actions for the developments, the respective forces of the assessed factors at the current stage are assessed to reveal the Current State of Forces. Should there be gaps in between the Target and the Current State of Forces, actions would be planned for closing the gap ***(Plan stage)***, and then the planned actions be implemented accordingly ***(Do stage)***. During the processes of the planned actions, that is, during the changes development stage, assessment based on the Framework would be conducted at planned intervals to reveal the updated state ***(Check stage)*** and then necessary adjustments would be made ***(Adjust/Act stage)***. The outlined steps of the Framework, in comparison with Lewin's Model, are shown in Figure 5-10.

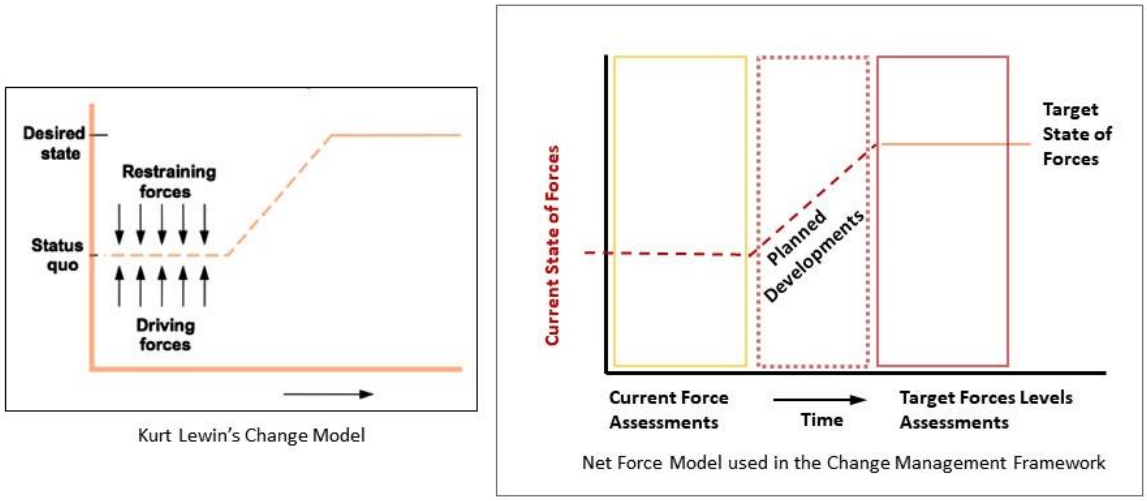


Figure 5-10 Change Management Framework (CMF) compared with Lewin's Change Model

Detailed descriptions of the way the Force Field concept is applied and the ways the net Forces are assessed and used would be covered below.

5.9.3 Structure of the Change Management Framework

The Change Management Framework is set up in an Excel file to facilitate inputs of data by the users, computation of the data and assessments, and display of the results. Altogether there are two worksheets named “Summary” and “Data”.

“Summary” Worksheet: this is the first worksheet which mainly contains the input data for particulars of the users/applicants using the Framework, outputs of the summary of the computed outputs from the “Data” Worksheet and the computed comparisons with previous assessments. In this “Summary” Worksheet, there are 6 functional segments, which have been divided into 8 sectors. The outline of its structure is shown in Figure 5-11.

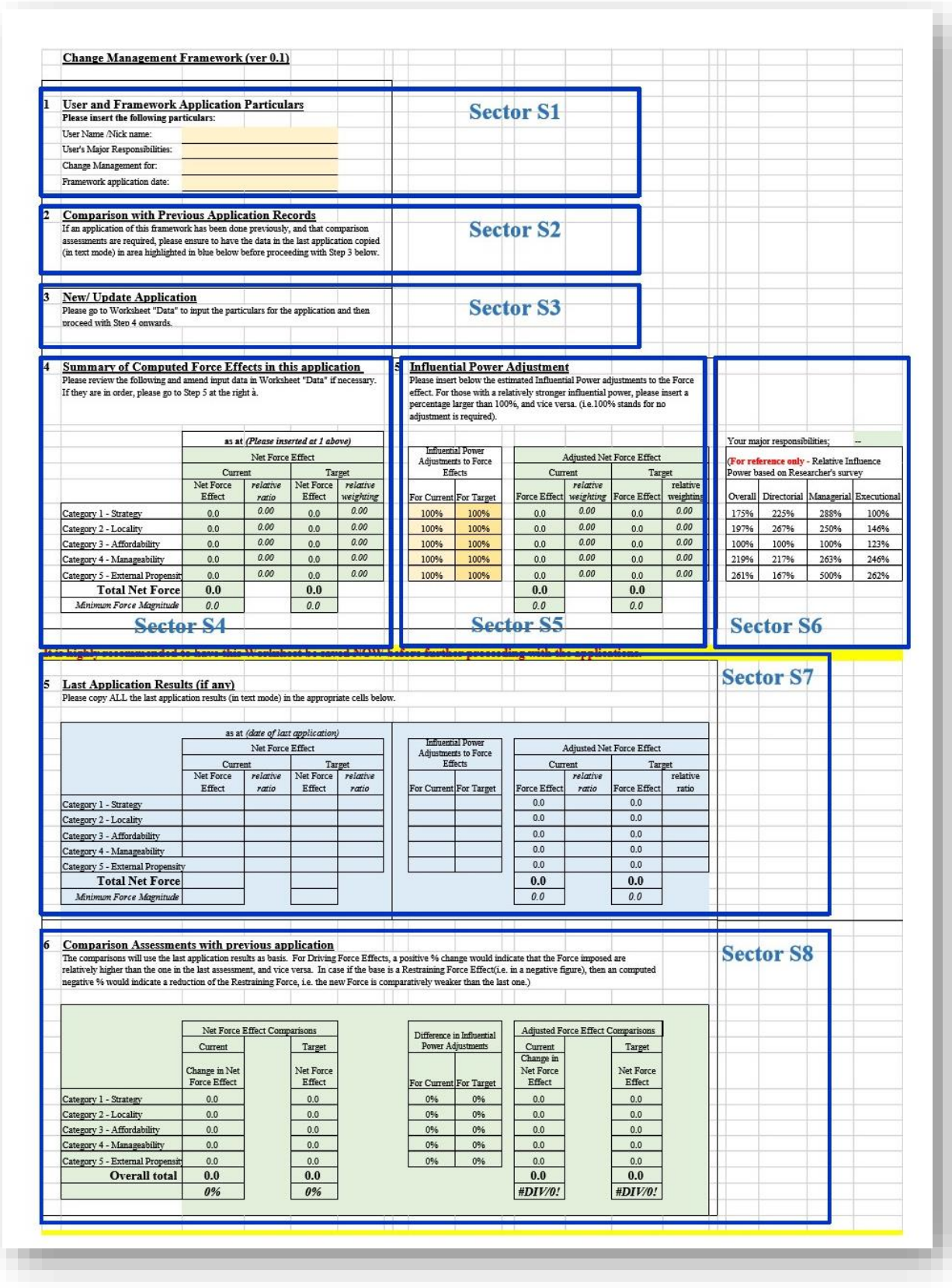


Figure 5-11 Structure of "Summary" Worksheet

"Data" Worksheet: The is the worksheet for inputting data for (a) the planned targets to be achieved; (b) the forces being imposed according to the current conditions; and (c) the ultimate forces that would be imposed after the targets have been achieved. An outline of the worksheet structure and the major sectors are shown in Figure 5-12.

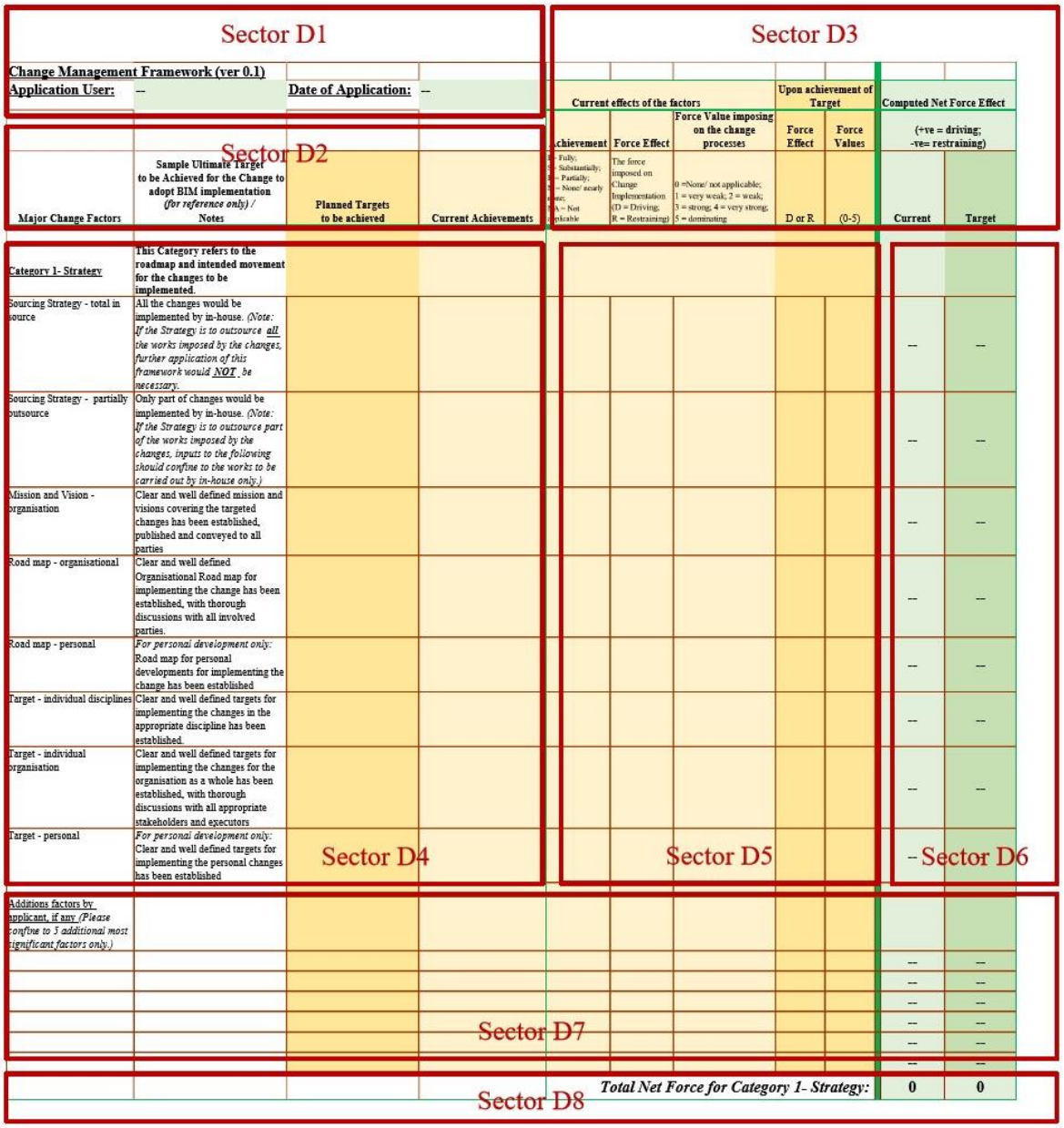


Figure 5-12 Structure of "Data" Worksheet

Altogether there are 5 categories of Theme Factors to be considered by the users. Sector D1 to D3 are standard headings for all categories. Sectors D4 to D8 as shown in the Figure 5-12 are input or output areas for Category 1 Theme Factors. The structure of the areas for the other 4 categories are the same and not repeated here.

A full set of the proposed Change Management Framework with details of all the templates is attached in Appendix 12 : *Full set of Change Management Framework (version 0.1)*.

Developments of these two Worksheets, together with the explanations on the rationale behind for the set up and procedures, inputs and outputs etc. in each of the segments and/or sectors would be covered below.

5.9.4 Set up and Explanatory Notes on the Change Management Framework

Below are step-by-step notes on the Framework setup, the way it should be used to achieve the desired objectives, together with the explanatory notes on the factors and issues that have been considered encountered during the developments. These notes would also serve as the "Users' Guideline" for using the Change Management Framework.

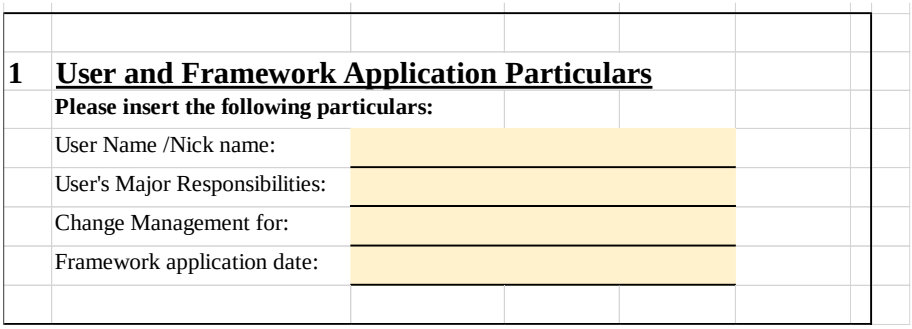
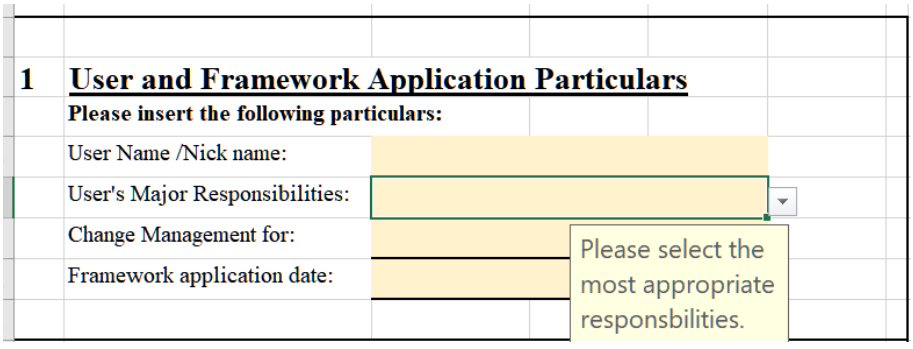


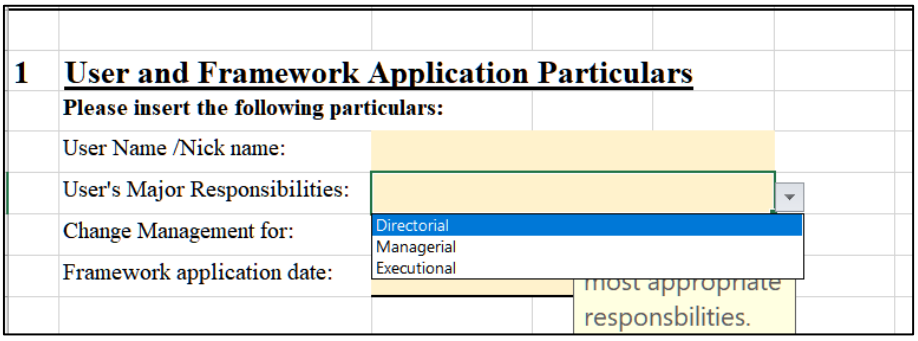
Figure 5-13 Worksheet "Summary" Sector S1:

Sector S1 is for insertion of profile outline of the user regarding his major responsibilities, whether the intended usage of the Framework is for BIM implementations for the organisation or his personal development.

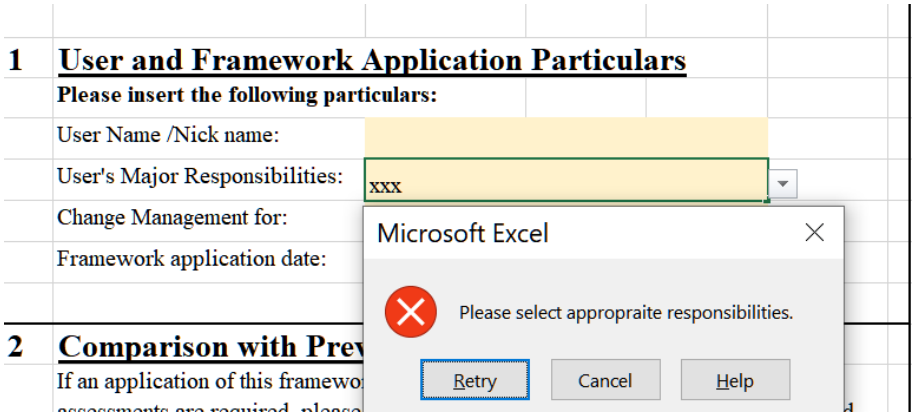
In order to ensure consistency and avoid inputs of invalid entries, validation checks have been incorporated. This is done by restricting the user to select the prescribed entries from the system, rather than inputting the data freely at his own style. In case if the prescribed entry is not selected, an alert would appear and the user is requested to select again. As an example, if the field "User's Major Responsibilities are shown below.



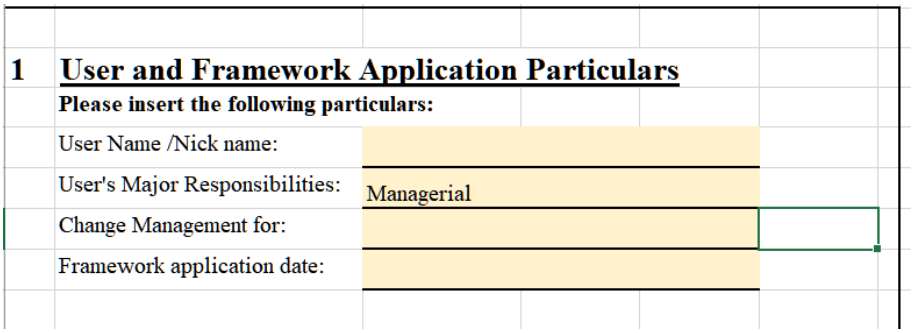
When the field is clicked, an input message will appear to guide the user to select the appropriate responsibilities.



When making the selection, a list of the prescribed entries will appear for the user to choose for inputting to this particular field. In case the user tries to input data other than the prescribed entries, an alert would appear to request re-selection of the appropriate one.



Until one of the prescribed entries is selected, the system will accept the entry and the user could continue inputting data to other fields. Example as below:



The fields of "User Name/ Nick name" and "Framework application date" are linked with the fields in Data S1, so that the user does not need to re-enter these data again. The advantage of setting up

such linkage is that consistency of the field contents could also be ensured. Below is a sample showing the connected linkages:

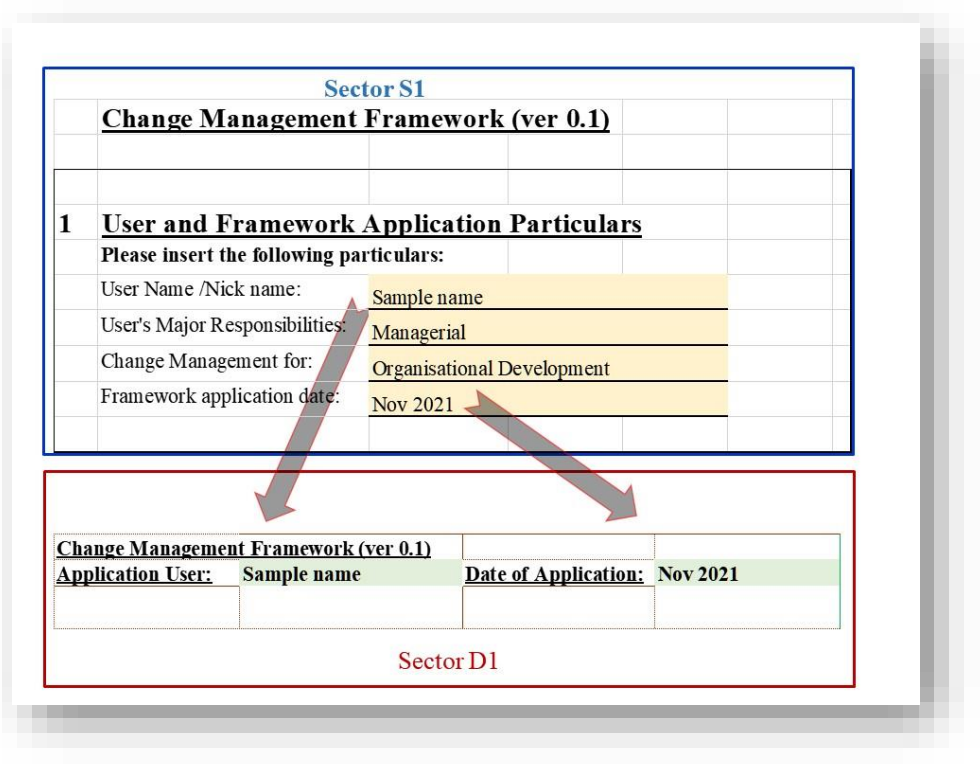


Figure 5-14 Worksheet "Summary" Sector S2

2	**Comparison with Previous Application Records**
	If an application of this framework has been done previously, and that comparison assessments are required, please ensure to have the data in the last application copied (in text mode) in area highlighted in blue below before proceeding with Step 3 below.

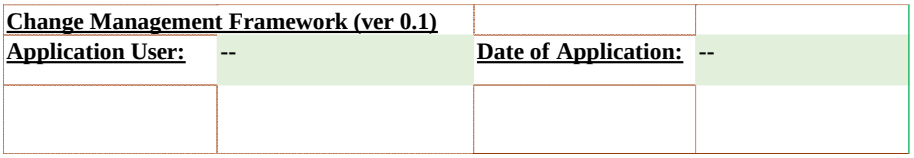
Sector S2 serves as a reminder to the user to copy the necessary data to Sector S7 Last Application Results if the same framework has been used for previous assessments. Since once the new data is loaded to the Worksheet, the assessment outputs would be automatically updated and the previous Application Results cannot be retrieved easily.

Figure 5-15 Worksheet "Summary" Sector S3:

3	**New/ Update Application**
	Please go to Worksheet "Data" to input the particulars for the application and then proceed with Step 4 onwards.

Sector S3 guides the user to go to the "Data" Worksheet of the Framework for inputting the required data. The "Data" Worksheet would serve as a structured framework, listing out the major change factors for consideration by the user, with provisions for the users to set the targets to be achieved, assess the resulting net force after taking into consideration of the "positive" driving forces pushing forwards to implement the changes, and the negative "restraining" forces from implementation.

Figure 5-16 Worksheet "Data" Sector D1:



After shifting to the "Data" Worksheet, the first sector the user will see is **Sector D1**. As mentioned above, he does not need to input the data in this Sector as the fields are linked to the inputs that he has made in Sector S1 before.

Figure 5-17 Worksheet "Data" Sector D2 and D4(part):

Major Change Factors	Sample Ultimate Target to be Achieved for the Change to adopt BIM implementation *(for reference only)* / Notes	Planned Targets to be achieved	Current Achievements
Category 1- Strategy	**This Category refers to the roadmap and intended movement for the changes to be implemented.**		
Sourcing Strategy - total in source	All the changes would be implemented by in-house. *(Note: If the Strategy is to outsource **all** the works imposed by the changes, further application of this framework would **NOT** be necessary.*		
Sourcing Strategy - partially outsource	Only part of changes would be implemented by in-house. *(Note: If the Strategy is to outsource part of the works imposed by the changes, inputs to the following should confine to the works to be carried out by in-house only.)*		
Mission and Vision - organisation	Clear and well defined mission and visions covering the targeted changes has been established, published and conveyed to all parties		
Road map - organisational	Clear and well defined Organisational Road map for implementing the change has been established, with thorough discussions with all involved parties.		
Road map - personal	*For personal development only:* Road map for personal developments for implementing the change has been established		
Target - individual disciplines	Clear and well defined targets for implementing the changes in the appropriate discipline has been established.		
Target - individual organisation	Clear and well defined targets for implementing the changes for the organisation as a whole has been established, with thorough discussions with all appropriate stakeholders and executors		
Target - personal	*For personal development only:* Clear and well defined targets for implementing the personal changes has been established		

Sector D2 comprises of the headings of the data that the users are required to input at **Sector D4** below for each of the categories. An abstract showing the headings in Sector D2 and part of the items in Sector D4 are shown in Figure 5-17. Below are the explanatory notes for each of them.

The first column under the heading "Main Change Factors" is for listing the Category and Theme codes identified for the major change factors. Users should review each of them and set the targets to be achieved against them at the third column under the heading of "Planned Targets to be achieved".

As a guide or reference for the users to consider, samples of some ultimate targets to be achieved for the change to adopt BIM implementation are listed in the second column. It is assumed that if such ultimate target is achieved, the maximum strength of driving force for the change would be reached. It would not be the case that all such targets would be intended to be, or could be, set as the target to be achieved. Individual users should review their own objectives, conditions and constraints etc in order to set the "Planned Targets to be achieved" and put them down in the third column.

After establishing the planned targets, the users should then review how much have such targets be attained and insert under "Current Achievements" in the fourth column. This is part of the "Assess" process in the APDRA cycle as defined in paragraph 5.9.1. The current status of the planned targets is to be assessed prior to Plan on actions to be taken further.

For example, if the planned target has already been achieved already, the planned action will focus more on how to maintain or freeze the situation but not for actions to be taken to achieve the target. For the Change Management Framework, it would mean that the planned "Force Effect" of the targets is already achieved. More details on this would be elaborated when discussing Sector D3, D5 and D6 below.

Altogether there are 5 Categories of Major Factors (as identified and explained in Chapter 4, paragraph 4.12.6.1), and a total of 21 factors with sample targets are listed in the Framework in Sector D4.

Sector D3 comprises the headings of the data to be input in D5 and those for the outputs to be generated by the system in D6. For **Sector D5**, there are 5 columns under 2 major headings, namely "Current effects of the factors" and "Upon achievement of Target".

For the columns under "Current effects of the factors": the users are asked to input the respective data against the Change Factor included in Sector D2. As a demonstration of how the inputs should be entered and outputs be generated, two simple entries have been entered under Category 1 and Category 3. Figure 5-18 is the abstract of such inputs and outputs and below are the explanatory notes for each of them.

			Current effects of the factors			Upon achievement of Target		Computed Net Force Effect	
			Achievement	Force Effect	Force Value imposing on the change processes	Force Effect	Force Values	(+ve = driving; -ve= restraining)	
Major Change Factors	**Planned Targets to be achieved**	**Current Achievements**	F= Fully; S= Substantially; P = Partially; N = None/ nearly none; NA = Not applicable	The force imposed on Change Implementation (D = Driving; R = Restraining)	0 =None/ not applicable; 1 = very weak; 2 = weak; 3 = strong; 4 = very strong; 5 = dominating	D or R	(0-5)	**Current**	**Target**
Category 1- Strategy									
Mission and Vision - organisation	Clear and well defined mission and visions covering the targeted changes has been established, published and conveyed to all parties	Only one clause showing the intention to change has been incorporated in the M&V.	P	R	3	D	5	-3	5
			Total Net Force for Category 1- Strategy:					**-3**	**5**
Category 3 - Affordability									
Resources availability - internal	Necessary internal resources, in addition to the external ones, are adequate to meet the change requirements.	Most of the required internal resources have been provided, pending those for purchase of upgraded software system and training	S	D	4	D	5	4	5
			Total Net Force for Category 3 - Affordability:					**4**	**5**

Figure 5-18 Sample entries and output in Sectors D4, D5 and D6

Planned Target to be achieved column: as mentioned earlier, the user should set the target to be achieved. In the example above, for Category 1, the target is set as to have "Clear and well-defined targets for implementing the changes for the organisation as a whole has been established, with thorough discussions with all appropriate stakeholders and executors".

Current Achievements column: the user shall review and input the status of the achievements of the target. For this example, it is found that "only one clause showing the intention to change has been incorporated in the M&V". With this in mind, it could be said that the Planned Target is only "Partially" achieved.

The entries above would be used as basis for assessment of the respective nature of force being imposed on the change implementation for BIM adoption as follows:

Columns under the "Current effects of the factors" group:

Achievement column: In line with the current status of this item, the data input for this factor "Mission and Vision – organisation" is "P", meaning the goal is partially achieved.

Force Effect column: this is based on the assumption that, after review, the user considers that with only one clause in the mission and vision statement, the implementation would be adversely affected. The force being imposed would be a kind of "Restraining" force and therefore the legend "R" is input against this factor by the user.

Force Value imposing on the change process column: the user is requested to assess and input the estimated magnitude of force (driving or restraining) that would be imposed by the change factor at the current condition. In this example, the user considers that without the full set of clear and defined mission and visions, the implementation would be very much hindered. He considers that the restraining force is "strong" and therefore input the respective force level of "3" for the current effect.

Columns under "Upon achievement of Target": After revealing of the current status, the user shall also assess that, when the target is achieved, what would be the nature of the forces to be imposed and its magnitude. In this example, he considers that if the target of establishing clear and defined mission and vision is achieved, it would impose a "driving" force with "very strong" force value. He therefore inputs "D" and "5" under the column "Force Effect" and "Force Values" in this group.

Note: The above covers some of the very difficult parts in setting up of the Change Management Framework. As mentioned before, each person or organisation is being affected by many different factors, performing different services with dissimilar targets, situated at different situations in terms of change implementations etc., no standardised measure could be set up for measurement of the force magnitude.

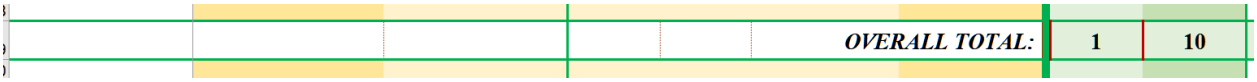
Finally, two approaches have been established to cater for this issue. The first approach is not to have the force measured or quantified. Instead, the user is asked to assess the quality of the impacts, that is, to use measurements in terms of the "perceived impacts" of "less concrete" nature without doing any precise calculations. The Likert Scale as mentioned in paragraphs under 2.8.2 on "Scaling of data is used as follows:

Scale	Force Magnitude
0	None/not applicable, that is not any force driving or restraining the implementation, or that the magnitude is relatively very minor and negligible. In case if the factor in concern is not applicable for being assessed and incorporated in the assessment, the scale of 0 shall also be used.
1 and 2	For factors with very weak or weak influencing forces.
3 and 4	For factors with very strong or strong influencing forces.
5	For factors with dominating forces which would either be having extremely large force or with the substantial effects. Factor with forces on this scale should be placed with high priority for being dealt with. Should it be a driving force factor, comparatively more efforts should be made to achieving it. Conversely, in case it is a factor imposing restraining force, more efforts should be made to eliminate it or to reduce its magnitude.

A positive value is assigned to each of the forces with a driving effect that facilitates the change implementation. Conversely, a negative value is assigned to those exercising restraining effects. Following this, in the above example, the current force of the mission and vision factor is assigned "-3", indicating that currently it is a restraining force, with a strong magnitude. However, upon achievement of setting up the targets, it would exert a dominating strong force to drive the implementations, thus a "+5" is used to denote its force. These two values are generated by the Change Management Framework system automatically and inserted under the respective column under the heading of "Computed Net Force Effect" as shown in Figure 5-18.

For each of the Category of factors, the total of the Computed Net Force Effects would be accumulated to generate the "Total Net Force". As there are only entries one of the factors only, the "Total Net Force" for this Category 1 – Strategy is also -3, and (+ve) 5 for the current status and target respectively.

Similarly, the factor of "Resources availability – Internal" is assessed, giving the Net Force of (+ve) 4 and (+ve) 5 for the current status and targets. All these computed values will then be added up and shown in **Sector D8** as shown below:



This computed total would be replicated in "Summary" Worksheet, **Sector S4**. More details would be covered in later paragraphs of this Chapter.

Based on the above example, it is concluded that currently, the magnitude of the Total Net Force imposing on the change implementation is 1, while the Total of the Target to be achieved is 10, indicating that the target achievement has not yet been achieved as a whole.

Note: The above has covered one of the two approaches adopted to cater for the issue of standardised measures. With the use of the standard scale, the strength of the forces being imposed by each of the individual factors could be determined. The computed totals of the Net Forces for each category would be able to serve to indicate the current status and the targeted ones based on common unit of forces.

However, the actual effects of each of such category of factors might not always be the same even if they are having the same scores. Different person or organisations might treat each of them differently and assign different weightings. Taking the targets of the two factors in the above sample as example, while the Net Force Effect for both of the two targets are the same at 5, some organisations may consider that the impacts imposed by each of them is not the same. For example, they may consider that relatively factors in Category 1: Strategy would have a higher influencing power that Category 3: Affordability. Alternatively, in terms of efforts, time and resources, the requirements for each of them may also be different. This leads to the necessity for another kind of adjustment on the force strength figures. The approach adopted is to introduce "Influence Factor Adjustment" factors. This would be covered in paragraph 5.9.5.

Worksheet "Data" Sector D7

Before moving on to the influence factor adjustment aspect, a note on the **Sector D7** in the "Data" Worksheet as shown in Figure 5-19 is to be given.

			Current effects of the factors			Upon achievement of Target	
			Achievement	Force Effect	Force Value imposing on the change processes	Force Effect	Force Values
Major Change Factors	**Planned Targets to be achieved**	**Current Achievements**	F= Fully; S= Substantially; P = Partially; N = None/ nearly none; NA = Not applicable	The force imposed on Change Implementation (D = Driving; R = Restraining)	0 =None/ not applicable; 1 = very weak; 2 = weak; 3 = strong; 4 = very strong; 5 = dominating	D or R	(0-5)
Additions factors by applicant, if any *(Please confine to 5 additional most significant factors only.)*							

Figure 5-19 Worksheet "Data" Sector D7

This Sector under each category provides space for the user to add any factors to be covered and assessed in the Framework. In this Sector, instead of "user", the term "Applicant" as the user is not only using the Framework but also inputting and applying his own data/information to the Framework.

Such additional factors to be input by the applicants may be those with particular concerns by the individual person or organisation, those arisen after implementation of the changes, or some newly emerged factors from the local, external or other communities. The concept of the Emergent Approach Theory mentioned in Chapter 2, paragraph 2.5.4 has been consulted for such provisions.

As pointed out by Burnes (2017), it is impossible for a few manages at the top of the organization to identify and implement all the change necessary to keep the organization aligned with its environment. With the factors considered, the planned targets need to be reviewed and amended appropriately during the implementation processes. For factors that are no longer applicable, they could be marked as not applicable "NA" accordingly under the "Achievement" column in the "Data" Worksheet. Additional factors could be added to **Sector D7** under the appropriate category and be assessed accordingly.

The above has covered all the sectors in the "Data" Worksheet. Thereafter, further assessments and computation would be done in the "Summary" Worksheet as follows.

5.9.5 Influence Factor Adjustment

As mentioned above, individual requirements for each Category of Factors would be different and thus provisions for necessary adjustments would be required. Such provisions are provided in the "Summary" Worksheet **Sector S4 and S5**. The procedures for making the adjustments would be given below.

To facilitate further processing, the totals of forces for each category computed in the "Data" Worksheet would be replicated in Sector S4 of the "Summary" Worksheet, as shown in Figure 5-20 Sample Summary of Computed Forces.

4 Summary of Computed Force Effects in this application

Please review the following and amend input data in Worksheet "Data" if necessary.
If they are in order, please go to Step 5 at the right.

	as at *Nov 2021*			
	Net Force Effect			
	Current		Target	
	Net Force Effect	*relative ratio*	Net Force Effect	*relative ratio*
Category 1 - Strategy	-3.00	*1.00*	5.00	*1.00*
Category 2 - Locality		*0.00*		*0.00*
Category 3 - Affordability	4.00	*1.33*	5.00	*1.00*
Category 4 - Manageability		*0.00*		*0.00*
Category 5 - External Propensity		*0.00*		*0.00*
Total Net Force	**1.00**		**10.00**	
Minimum Force Magnitude	*3.00*		*5.00*	

Figure 5-20 Sample Summary of Computed Forces

The forces are replicated for each of the categories under the heading of "Net Force Effect", as they have not been adjusted for any necessary weighting. The relative ratio of the magnitude of these net effects are computed and shown under the heading of relative ratio. In the sample above, the Current Net Force Effect of the factors under Category 1 is have a magnitude of 3 (irrespective of its driving or restraining nature). Relatively Category 3 with the magnitude of 4 is larger than Category 1, being 1.33 larger. Force magnitudes of the targets of these two Categories are both at 5, and therefore their relative ratio is 1, that is, the same with each other.

The user would review if this ratio is appropriate for use. As an example, in the sample above, the user considers that Category 1 factors would actually have a relatively stronger impact than those being imposed by Category 3. In response, he would want to increase the weighting of Category 1 forces. He would then use Category 3 Net Force as the base and weigh it at 100%, followed by a higher percentage weighting to the Net Force of Category 1 to reflect its stronger influencing power.

Suppose the weighting he has given to Category 1 is 175%. After applying this weighting, the current and target forces of Category 1 will be adjusted from -3 and 5 to -5.25 and 8.75 respectively. The force of Category 3 would remain unchanged, as shown in Figure 5-21.

	Net Force Effect					Influential Power Adjustments to Force Effects		Adjusted Net Force Effect			
	Current		Target					Current		Target	
	Net Force Effect	*relative ratio*	Net Force Effect	*relative ratio*		For Current	For Target	Force Effect	*relative weighting*	Force Effect	relative weighting
Category 1 - Strategy	-3.00	*1.00*	5.00	*1.00*		175%	175%	-5.25	*1.00*	8.75	*1.75*
Category 3 - Affordability	4.00	*1.33*	5.00	*1.00*		100%	100%	4.00	*0.76*	5.00	*1.00*
Total Net Force	**1.00**		**10.00**			**(CI)**	**(TI)**	**-1.25**		**13.75**	
	(CF)		**(TF)**					**CF x CI**		**TF x TI**	

Figure 5-21 Sample of Adjusted Net Force Effects

From the table at the right, under the heading of "Adjusted Net Force Effect", it could be observed that the current adjusted Total Net Force would become -1.25 (CFxCI) instead of the 1 (CF) as shown in the table at the left under the heading of "Net Force Effect". This has indicated that, after consideration of the relative weightings, the Total Net Force imposing from current situation of the organisation on the change implementation for BIM adoption is in fact on the negative side, that is, acting as a "Restraining" force. Regarding the Target Net Forces, the Total Net Force Values of the target would also be adjusted from 10 to 13.75 accordingly. These adjusted values would better reflect the actual situation of the organisation. Figure 5-22 is a consolidated Force Model incorporated with the value of the Net Force Effects and Adjusted Net Force Effects.

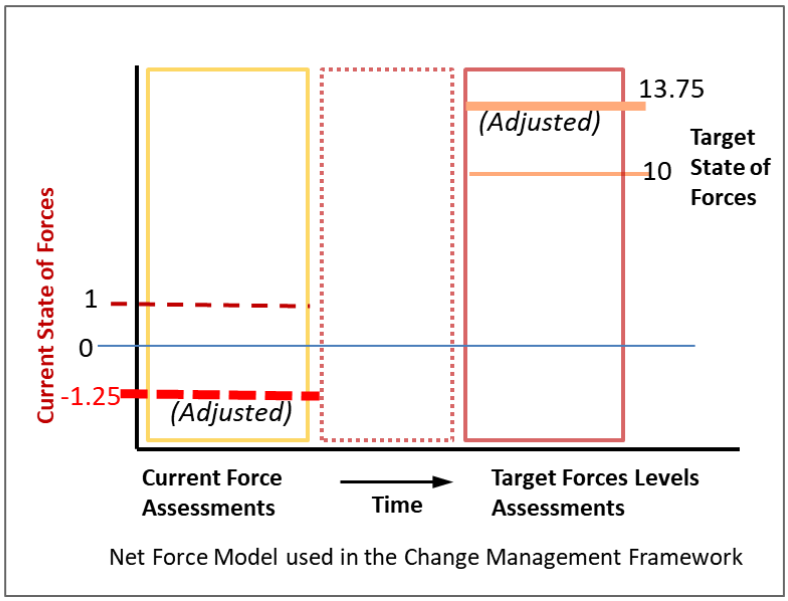


Figure 5-22 Force Model with Value of Net Force Effects

Up to this stage, illustration of the first objective of the Change Management Framework in serving the assessment processes, is completed. It is believed that with the calculated raw and adjusted force values, the person or organisation could have a clear view on the targets to be achieved and the current status. The "Assessment" process in the **APDRA** cycle addressed in paragraph 5.9.1 is completed and the user could go further on planning of appropriate actions and continue with the processes illustrated as follows.

*Assessment with **CMF**(completed) →*
*(to continue to) **P**lan – **D**o – **R**eassess (with **CMF**) – **A**ct/ **A**djust*

5.10 The Case Study

As mentioned in Chapter 3, paragraph 3.9, a case study to test-run the Change Management Framework shall be conducted in order to obtain more background information for further review or enhancement of the framework. Below is the report on the study conducted.

5.10.1 Case Study Scope and Objective

Since construction projects would normally span over four to five years, it might not be able to conduct the test-run for all the stages for a new project. In view of this, the case study for this particular paper is limited to those with a specific timeframe only. The objective of the case study is to trial run is to obtain results for exploration and provision of further information for future research or application of the framework in other cases, if any.

5.10.2 Case study processes

With the agreement from one of the interviewees, a trial run of the proposed Framework was conducted with him. In order to avoid any potential exposure, his PIS (Participant Identification Number) is not used but being named as the "case study participant".

Prior to conducting of the case study, a briefing on the proposed framework, its objective, and its developments had been presented to the case study participant. After seeking his agreement, the Framework was forwarded to him for initial review and study, followed with another briefing session on each part of the Framework, their requirements etc. After that, the case study participant input the necessary data in accordance with the current status and conditions to reveal the Net Force Effect of the factors that were currently exerting on BIM implementation for his organisation.

To avoid any unnecessary interference or imposing any biased opinions to the case study participant, after the briefing session, he was asked to input on his own. Should there be any problem or doubts in any of the items, he might skip them and then reviewed those with me afterwards.

The inputting processes was done smoothly and the participant could input all the necessary data without any problem.

5.10.3 Case study results and reflections

The following are the abstracts of the results captured from the Framework that the case study participant provided. Notes on the findings together with the reflections, if any, are reported below.

Worksheet "Summary" item 1 (Sector S1):

1	**User and Framework Application Particulars**	
	Please insert the following particulars:	
	User Name /Nick name:	Case study participant
	User's Major Responsibilities:	Directorial
	Change Management for:	Organisational Development
	Framework application date:	December 2021

The above is the outline of particulars of a case study participant, showing that his major responsibilities are of Directorial level, and that the intended usage of the Framework is for BIM implementations for the organisation, i.e. not for his own personal development.

In accordance with the guidelines given in Sector S3, the case study participant shifted to the "Data" Worksheet and input the information accordingly. A copy of the inputs provided by the case study participant in this worksheet is attached in Appendix 13: *Case Inputs in the Data Worksheets by the case study participant*.

5.10.3.1 Summary of Force Effects and relative ratio

Based on the inputs by the case study participant, the Net Force Effects are computed and listed in Sector S4 of the "Summary" Worksheet, as shown in Figure 5-23.

	as at	***Dec 2021***		
	Net Force Effect			
	Current		Target	
	Net Force Effect	*relative ratio*	Net Force Effect	*relative weighting*
Category 1 - Strategy	23.00	*11.50*	27.00	*2.70*
Category 2 - Locality	7.00	*3.50*	19.00	*1.90*
Category 3 - Affordability	6.00	*3.00*	10.00	*1.00*
Category 4 - Manageability	-2.00	*1.00*	18.00	*1.80*
Category 5 - External Propensity	10.00	*5.00*	13.00	*1.30*
Total Net Force	**44.00**		**87.00**	
Minimum Force Magnitude	*2.00*		*10.00*	

Figure 5-23 Case Study - Summary of Computed Net Force Effect

As an indication from the above results, after achieving all the Targets, the Total Net Force would be 87. The Total is positive and therefore is a Driving Force.

Note: The computed Net force based on the current status of the factors is also positive, at 44, but much below the target force of 87. This would indicate that much effort would still be made in order to achieve the targets and attain the required Force value. It may also be observed that the force being imposed on Category 4 – Manageability is currently a restraining one. While the magnitude of the force of this Category is relatively the smallest, scrutiny of the factors in this Category would still be necessary as in fact, after achieving the target, its relative force ratio is 1.8, which is the third highest.

The relative ratios of the forces would also serve the purpose of indicating their importance, thus aiding in planning for resources or prioritisation of the works etc. in the planning process.

5.10.3.2 Adjusted Force Effects

As discussed in paragraph 5.9.5, the case study participant might need to apply adjustments to the computed Net Force Effect to reflect the effects more related to the environment of the organisation. For this, the case study participant has been briefed about such intended objective. Also, during the briefing, the participant was informed that in Sector S6 in the Worksheet "Summary", as shown in Figure 5-24 , a list reference factors for the "Relative Influence Power Adjustment" for each of the Categories, based on my survey findings are provided.

	Your major responsibilities;			Directorial
	(**For reference only -** Relative Influence Power based on Researcher's survey			
	Overall	Directorial	Managerial	Executional
Category 1 - Strategy	175%	225%	288%	100%
Category 2 - Locality	197%	267%	250%	146%
Category 3 - Affordability	100%	100%	100%	123%
Category 4 - Manageability	219%	217%	263%	246%
Category 5 - External Propensity	261%	167%	500%	262%

Figure 5-24 Relative Influence Power Adjustment - Reference Factors

The case study participant is also well informed that these calculated factors are merely for use as reference only and need not be followed. Instead, users shall review the actual situations, including the requirements, constraints and assign appropriate factors to each of the categories.

He is also advised how these relative influence power adjustment factors are derived. For this, the explanatory notes are provided here. The relative influence power percentages in the table are derived from calculating the counts of Theme Codes of the interviewees' responses to the interview questions by the interviewees for each of the Categories. The concept followed is that a Category with more counts of related theme codes would indicate that it is perceived to be more important and have higher influencing power on change implementations. In this regard, the Category with the smallest number of theme code counts would be used as the base, assigned with a factor of 100%, the others will be assigned with a larger percentage to reflect their relatively higher influence power.

As an example, from the overall summary of the Theme code counts as listed in paragraph 4.12.6.1 Theme Categories, it is found that the total theme code count of 36 for Category 3 is the smallest. Its relative influence power is assigned to be 100%. When this weighting is applied in multiplying the Net Force Effect, there will not be any change in the value. For Category 1 – Strategy, the Theme Code count is 63. Its relative Influence power factor is calculated as 63÷36 = 175%. Once this factor is applied, the Net Force Effect would be increased accordingly.

In addition to the relative influence power based on an overall total of the 343 code counts, the relative powers based on the Major Responsibility of the interviewees are also calculated, the calculated weightings are copies at Sector S6 for reference by the users. Details of the code counts and calculations are shown in the figure below.

	Theme Code Count				Relative Influence Power			
		by Major Responsibilities Category			(Based on Smallest Code Count = 100%)			
Theme Category	Overall	Directorial	Managerial	Executional	Overall	Directorial	Managerial	Executional
1. Strategy	**63**	**27**	**23**	**13**	175%	225%	288%	100%
2. Locality	**71**	**32**	**20**	**19**	197%	267%	250%	146%
3. Affordability	**36**	**12**	**8**	**16**	100%	100%	100%	123%
4. Manageability	**79**	**26**	**21**	**32**	219%	217%	263%	246%
5. External Propensity	**94**	**20**	**40**	**34**	261%	167%	500%	262%
Total	**343**	**117**	**112**	**114**				

Figure 5-25 Theme Code Count and Relative Influence Power of Factors calculations

Eventually, the case study participant reviewed these weightings and consider that those listed under "Directorial" are relevant and appropriate for use for his organisation. The adjustment weightings used, and the Adjusted Net Force Effects are shown in Figure 5-26.

	as at *Dec 2021*									
	Net Force Effect				Influential Power Adjustments to Force Effects		Adjusted Net Force Effect			
	Current		Target				Current		Target	
	Net Force Effect	*relative ratio*	Net Force Effect	*relative ratio*	For Current	For Target	Force Effect	*relative ratio*	Force Effect	*relative ratio*
Category 1 - Strategy	23.00	*11.50*	27.00	*2.70*	225%	225%	51.75	*11.92*	60.80	*6.08*
Category 2 - Locality	7.00	*3.50*	19.00	*1.90*	267%	267%	18.69	*4.31*	50.70	*5.07*
Category 3 - Affordability	6.00	*3.00*	10.00	*1.00*	100%	100%	6.00	*1.38*	10.00	*1.00*
Category 4 - Manageability	-2.00	*1.00*	18.00	*1.80*	217%	217%	-4.34	*1.00*	39.10	*3.91*
Category 5 - External Propensit	10.00	*5.00*	13.00	*1.30*	167%	167%	16.70	*3.85*	21.70	*2.17*
Total Net Force	**44.00**		**87.00**				**88.80**		**182.30**	
Minimum Force Magnitude	*2.00*		*10.00*				*4.34*		*10.00*	

Figure 5-26 Influence Power Adjustment and Adjusted Net Force Effect

After the adjustment, it could be observed that the Target Force Effects has changed substantially after application of the adjustments. As discussed earlier, the adjusted Force Effect would be in a better position to express the actual Force Effect to be achieved in order to achieve efficient and effective change implementations.

5.10.4 Feedbacks on case study

In general, the feedback from the case study participant is positive and encouraging. The participant commented that in the briefing session, I had demonstrated to him this was a rich and insightful study. He opined that the Framework has been established with thorough review of the factors affecting change implementation for Building Information Modelling (BIM) adoption. With the factors and targets introduced in the Framework and the capability in assessment of the current forces being imposed and the targeted forces required for the implementation, planning for the actions to be taken and soliciting appropriate resources would be facilitated. With these capabilities, the Framework would effectively facilitate users to proceed with effective and efficient BIM implementation processes.

However, he advised that it would be desirable to have more in-depth explanation of the Framework objective, rationale behind for the required input and usage of the outputs, so that users would feel more confident and motivated to use the Framework. This would be considered in future actual application of the Framework.

5.11 Change Management Framework and Case Study - Terms and Notes

To serve as a summary, below are explanations and notes on the terms used in the Framework and/or emerged from the findings. The summary could also be used as basis for further research in relation to change management and governance for adoption of the new technologies or processes etc.

To facilitate the ease of tracing, the terms in the summary are listed in line with the sequence of the Case Study covered in paragraphs under 5.10. Reference to notes or explanations described in other paragraphs are also added as supplements and marked with a prefix of "#" where appropriate.

Reference	**Terms**	Definition/ Notes
Paragraph 5.10.3.1; Figure 5-23 Case Study - Summary of Computed Net Force Effect	**Force Effect**	"Force Effect" refers to the nature of the forces imposed by the change factor, i.e. is it a force driving towards implementation (D), or restraining (R) from changes. Each of them is assigned with the "Force Value". For the purpose of calculating the net effects, a positive (+ve) value is assigned to driving forces, and a negative (-ve) value is assigned to restraining forces.
#Page 142, Figure 5-18 Sample entries and output in Sectors D4, D5 and D6	**Force Value**	"Force Value" is the magnitude of force, in terms of numeric values, assigned to the "Force Effect" imposed by the change factor. A scale of 0 to 5 is used to represent the strength of magnitudes as follows: 0 = none/ not applicable; 1 = very weak; 2 = weak;

		3 = strong; 4 = very strong; 5 = dominating.
Paragraph 5.10.3.1; Figure 5-23 Case Study - Summary of Computed Net Force Effect #Page 146, Figure 5-20 Sample Summary of Computed Forces	**Net Force Effect**	The "Net Force Effect" is the net total of the values of all the "Net Force" for the change factors in the category. It could be defined as the result of subtracting the total value of the force restraining change implementation from the driving forces pushing forwards to implement the changes, i.e.: *Value of Net Force Effect =* *Value of Driving Force –Value of Restraining Force* After the subtraction, if the "Net Force Effect" is a positive value, it would indicate that there are driving forces pushing forwards to implement the changes, thus facilitating achievement of target changes to be implemented. Conversely, a negative "Net Force Effect" would indicate that there are forces resisting the change implementation, acting as "restraining" forces from implementation of the targeted changes.
	Current Net Force Effect and **Target Net Force Effect**	"Current Net Force Effect" means the net force imposed by the change factors at the present situation. "Target Net Force Effect" refers to the anticipated net force that would be imposed by the change factor after reaching the targeted achievements.
	Relative Ratio	This is the ratio of the Net Forces of a Category of change factors when compared with the others. It is calculated as follows: *Relative ratio = Value of Net Force of the particular Category ÷ Value of the smallest Net Force amongst all categories* Absolute value of the Net Force values would be used. The objective is to show the relative weighting and thus the importance of each of the categories. The "Relative Ratio" for the Category with the smallest value of Net Force would be 1.00, while the ratio of those with higher value of Net Force would be larger than 1.00.

		Users might review if the calculated "Relative Ratio" of each of the categories is appropriate for use for their organisation. Where necessary, they might apply the "Influencing Power Adjustment" to work out the adjusted ratio and the adjusted "Net Force Effect" of the category in concern.
Paragraph 5.10.3.2; Figure 5-24 Relative Influence Power Adjustment - Reference Factors; and Figure 5-25 Theme Code Count and Relative Influence Power of Factors calculations #Page 116, Paragraph 4.12.7 The Power of Influence #Page 147, Figure 5-21 Sample of Adjusted Net Force Effects	**"Relative Influence Power Adjustment"**	Different person or organisations might treat each of them differently and place dissimilar weightings. Instead of adopting the calculated "Relative Ratio", users might base on their requirement to adjust the weighting of each of the Category of Change Factors. These "Relative Influence Power Adjustment Factors" are expressed in terms of percentages for users to apply as adjustments to the value of "Net Force Effects". Applying an adjustment factor of larger than 100% to the original "Relative Ratio" of a Category of Change Factors would raise its ratio and thus increase the value of its "Net Force Effect". Conversely, the application of an adjustment factor smaller than 100% would lower the ratio and the "Net Force Effect". Users may adopt 100% as the adjustment factor if no adjustment is required.
#Page 117, Table 4-15 Relative	**"Influence power Adjustment" – Reference factors**	These are figured sample factors for references by the users. They are computed percentages based on the results from the researcher's surveys. Users of the Change Management Framework (CMF) are informed that these are merely for use as reference only and need not be followed. Instead, they shall review the actual situations, including the requirements, constraints etc and assign appropriate factors to each of the categories.
Figure 5-26 Influence Power Adjustment and Adjusted Net Force Effect	**Adjusted Net Force Effects**	The "Adjusted Net Force Effects" are the product of "Net Force Effects" and the "Influence Power Adjustment" factors input by the user. These adjusted force effects would be used to facilitate planning and allocation of resources for change

#Page 116, Paragraph 4.12.7 The Power of Influence #Page 145, Paragraph 5.9.5 Influence Factor Adjustment		implementations, taking into account of the user's desired adjustment.

5.12 Extended application of the Case Study Results

Originally, after completion of the above, the intended processes of the case study have been fully completed. As this is the first time the Framework is being used, there is no previous application result, thus the related processes in Sector S7 and S8 for Comparison Assessment with previous applications could not be dealt with.

However, for test running of the comparison capability, based on the advice given by the case study participant, estimated Net Force Effects in a year before the case study, that is in December 2020, have been prepared and input into the Framework. The outcomes are shown in Figure 5-27 below.

as at *Dec 2020*	Net Force Effect				Influential Power Adjustments to Force Effects		Adjusted Net Force Effect			
	Current		Target				Current		Target	
	Net Force Effect	*relative ratio*	Net Force Effect	*relative ratio*	For Current	For Target	Force Effect	*relative ratio*	Force Effect	relative ratio
Category 1 - Strategy	1.00	*0.50*	27.00	*2.70*	225%	225%	2.25	*0.52*	60.80	*6.08*
Category 2 - Locality	1.00	*0.50*	19.00	*1.90*	267%	267%	2.67	*0.62*	50.70	*5.07*
Category 3 - Affordability	5.00	*2.50*	10.00	*1.00*	100%	100%	5.00	*1.15*	10.00	*1.00*
Category 4 - Manageability	-10.00	*5.00*	18.00	*1.80*	217%	217%	-21.70	*5.00*	39.10	*3.91*
Category 5 - External Propensit	4.00	*2.00*	13.00	*1.30*	167%	167%	6.68	*1.54*	21.70	*2.17*
Total Net Force	**1.00**		**87.00**				**-5.10**		**182.30**	
Minimum Force Magnitude	*10.00*		*10.00*				*21.70*		*10.00*	

Figure 5-27 Estimated Net Forces in earlier applications

From the above, it could be observed that after applying of the influence power adjustment, it is found that the Force Effect imposed in December 2020 would be of Restraining nature as it is a negative value. Before applying the adjustment, the Net Force Effect is positive and would be interpreted as a Driving Force.

Data in the above Figure 5-27 has been used as the basis for comparison with those in December 2021. The results are shown in Figure 5-28 below:

Comparison Assessments with previous application

	Net Force Effect Comparisons				Difference in Influential Power Adjustments		Adjusted Force Effect Comparisons			
	Current		Target				Current		Target	
	Change in Net Force Effect		Net Force Effect		For Current	For Target	Change in Net Force Effect		Net Force Effect	
Category 1 - Strategy	22.0		0.0		0%	0%	49.5		0.0	
Category 2 - Locality	6.0		0.0		0%	0%	16.0		0.0	
Category 3 - Affordability	1.0		0.0		0%	0%	1.0		0.0	
Category 4 - Manageability	8.0		0.0		0%	0%	17.4		0.0	
Category 5 - External Propensit	6.0		0.0		0%	0%	10.0		0.0	
Overall total	**43.0**		**0.0**				**93.9**		**0.0**	
	4300%	Addition in Driving Force	***0%***	Addition in Driving Force			***-1841%***	Reduction in restraining force	***0%***	Addition in Driving Force

Figure 5-28 Comparison Assessments with previous application

It could be observed that based on the estimates, there has been much effort made in achieving the targets. For the current Net Force Effects, the Force Effects for all categories have been have increased. In particular, the one for Category 1 – Strategy has increased by 22, and 49.5 after adjustment for the influence power. This increase has contributed the most to the overall total. Before adjustments, the overall total has been increased by 4300%, because the added Total Force effect is 43 while that in Dec 2021 was only 1.

Regarding the comparisons of the adjusted Force Effect, it could be noted that the compared output of 1841% is labelled as a negative value. This is because in Dec 2021, the base value of the Total Net Force is a negative value. For this observation, a note is added besides this result to clarify that it is in fact a reduction in restraining force, a de facto improvement.

With such extended application, a complete run through of the entire Change Management Framework has been completed and that the Case Study exercise is also completed.

5.13 Reflection

The long journey in literature review, secondary research and primary research, and the complicated and complex project activities, have been completed. Having said so, I would foresee that there are still opportunities for further research in related areas that would result in more contributions to the construction industry. Suggestions on possible future research, together with the conclusions, recommendations and learning outcomes of the project would be covered in the next chapter.

Chapter 6 Conclusion, Future Research and Reflection

6.1 The Completed Tasks

The objective of this research project is to review the effects and consequence of the benefits and barriers of BIM implementations, and to examine if the extent of these effects could be strengthened, alleviated or eliminated in order to achieve effective and efficient BIM implementations. The following is an account of what have been done in this research project in order to achieve the objective.

6.1.1 Review on factors influencing Building Information Modelling (BIM) implementation

On the part of "effects and consequence of the benefits and barriers", both technological factors and non-technological factors that would have influence on management of changes for BIM implementations have been studied and analysed. In order to conduct more in-depth analysis for revealing the impacts of the change factors, the factors have been separated into four segments, namely "Subject Substance", "Subject Attribute", "Object Substance" and "Change imposed".

After application of such segment separation processes, the change factor components could be identified in a clearer manner. As an example, based on analysis of the missions and visions statements of 144 BIM related organisations, it is found that there are 94 Object Substances. However, only five of them are the common one. Based on this finding, it could be concluded that at this stage, in line with these organisations' current vision for future goals, there are five Object Substances commonly considered in the changes for BIM implementations. The reflection for this particular process is that a rich description of the data set would be able to provide clearer and thorough understanding of the predominant, important elements of the factors to be considered for implementation.

Detailed findings of the above processes are reported in Chapter 4. The concepts and principles about the non-technical factors learned from studies of change theories and models, etc., together with the researcher's own experience and knowledge, have formed sound basis for the primary research and used as basis for the secondary research including the establishment of the interview questions and guidance notes. Altogether twelve experts in the construction industry have been interviewed. Their responses are analysed in accordance with the Theme Analysis procedures. Finally, a set of five major themes is established in categorizing the 21 theme codes obtained from coding of the interviewees' responses. Detailed report on the processes and findings from the theme analysis are covered in Chapter 4, paragraph 4.9 to 4.12. After this, the first part of the objective regarding reviews of the factors is completed.

6.1.2 Establishment of the Change Management Framework

Regarding the part on achieving effective and efficient BIM implementation, the approach adopted is to take into consideration the findings from the research as mentioned above, and then to conclude, formulate and recommend a way forward with the Change Management Framework. The objectives are to facilitate practitioners on the right path to alleviate the adverse effect of the

barriers or problems, and to effectively manage the changes so as to ensure effective and efficient BIM implementation processes. In effect, achieve most of the BIM potential benefits eventually.

Prior to establishment of the Change Management Framework, the findings from the research have been further analysed to reveal the inter-relationships amongst the environments of persons, organisations, local communities, external and other communities. The analysis reveals the complications of the cultural issues, the varied nature of influencing forces being imposed amongst the different entities, and the complexity of the compositions of the organisations in the construction industry. As a result, it is found that the interrelationship between change factors, and the pattern, nature, magnitude and effect of the influencing power amongst organisations would not be the same but different from each other without any definable pattern. It is considered that the establishment of a standardised measurement of the level of driving or restraining forces being imposed or received by the parties would not be feasible and in fact would not be realistic or practical for use, even if it is developed.

To have this issue addressed in a satisfactory manner, the approach adopted is that, instead of attempting to establish a comprehensive framework covering all the requirements by all different persons or organisations, a structured framework for guiding and leading the users to review and plan for appropriate actions should be established. Along the line of this approach, the Framework is established with a concentration on the part on review and assessment, leaving the users to review their own conditions and requirements to develop the action plans that they consider appropriate. The rationales behind, the framework design development processes, compositions of the framework, and detailed application procedures in using the framework aided with figured examples for illustrating the input and output processes, are reported in Chapter 5, paragraph 5.9.

6.1.3 Case Study

After completion of the Change Management Framework, a case study with the objective to trial run the Framework and to obtain results for exploration and provision of further information for future research or application of the framework is conducted. A report of the case study featuring the results and notes on indications has been covered in Chapter 5, paragraph 5.10.

6.2 Conclusion

As indicated from the above reports, it could be concluded that all the proposed tasks have been completed and reported in the earlier chapters. Below are notes on how the objectives of the research project (as listed in Chapter 1, paragraph 1.5) have been achieved by these works done:

Objective 1 - to review and identify the underlying barriers in BIM implementation that have been in existence, and those newly arisen after the mandate of BIM use by the Hong Kong Government: the review and identifications have been firstly covered in the secondary research, and then further examined and analysed in the primary research on mission and vision analysis and interviews. The findings have been consolidated as the major change factors and proposed targets to be achieved for implementation and incorporated as part of the Change Management Framework.

Objective 2 - to review and evaluate the rationale behind of the existence and the impacts of such barriers on the BIM implementation processes and Objective 3 - to review and analyze practical problems and influencing factors that would also have effect on successful BIM

implementation processes: the interlinks and relationships of the various entities have been revealed and analysed with the underlying concept of Knowledge Cultures. Using the Force Field theory as the basis, the influences on change implementations being imposed by different entities are expressed as Driving or Restraining Forces. These have been incorporated as part of the Change Management Framework to facilitate assessment of the impacts.

Objective 4 - to review other non-technical factors such as cultural and organisational developments etc. and the theories and concepts behind that would need to be considered in managing the changes imposed from BIM implementations: these have also been covered in both the secondary and primary research. The non-technical factors identified have also been taken into consideration and incorporated as part of the Change Management Framework.

Overall Objective: Taking into consideration the results of the above, to conclude, formulate and recommend the way forward in a change management framework with the objective to alleviate the adverse effect of the barriers or problems, to effectively manage the changes so as to ensure effective and efficient BIM implementation processes with implied potential benefits: the Change Management Framework that has been established and a case study with a trial run of the Framework has been conducted. The outcome of the case study proves that the Framework is ready for being used would provide a structured approach for the users to assess the force effects being imposed on the change in BIM implementation processes, as well as to facilitate the users to plan for the targets to be achieved and enabling them to review and reassess for necessary adjustments in later stages.

To sum up, all the research objectives have been achieved satisfactorily.

6.3 The Contributions

The major contribution of this research project would be the development of the structured approach for identification and analysis of change factors. With this approach and the application of force effects on influence powers being imposed by the various factors, the source, nature and impact of the change factors could be identified. Such an all-rounded analysis and identification of change factors are essential for effective BIM implementation processes. Due to the complexity nature of the construction industry, however, identification of such factors was difficult and could not be conducted effectively.

Furthermore, unlike other changes on adoption of new technology or processes, the processes for Building Information Modelling adoption need to be done not only by each individual person or individual organisation but also by concerted effort involving organisation, disciplines, and parties with work relationship. Furthermore, the influences on the pace and outcome of the implementation are affected by external entities. The extent of such influencing parties even extends to entities without any direct work relationship. Efficient and effective implementation for Building Information Modelling adoption could only be well managed if equipped with a clear all-rounded knowledge in the change factors. The findings of this research project and the established Change Management Framework would enable the achievements of all these requirements.

For the identification and analysis of change factors, the segment breakdown approach developed for this research project for change factor analysis has been used. The results have proven the capability of this methodology to create clarity for researchers in the course of identifying the

objects (Object Substances) to be changed. Setting targets to be achieved is one of the primary major task elements for any intended change. With such clarification of the object to be changed, coupled with the theme analysis that has been carried out, a clearer path for the target setting is provided. Another identified segment of the change factors, the Subject Substance (SS), has also demonstrated their powerful strength in identification of the Theme Factors and thus facilitates completion of the Change Management Framework establishment.

The Culture Knowledge Model studied has given me an in-depth insight in categorising knowledge and the relationships amongst each of them. After taking into account of the sector settings suggested by this model, and incorporation with the related scope, extent and nature of the Subject Substances of the change factors, the inter-relationships amongst the various sectors imposing influences on change implementations is portrayed. The outcome of the portrayed compositions of all the possible relationships regarding influences are even more complicated than the Culture Knowledge Model. With the aid of the Subject Substances identified from the change factor analysis, appropriate grouping of the entities with similar pattern and nature of influencing forces could be set up.

However, despite the provision of the successful Subject Substances identification and clearer portrayed interrelationships, the reality is that the compositions of the organisations in the construction industry are complex and complicated and that the interrelationship, pattern, nature, magnitude and effect of the influencing power amongst organisations are different from each other, leading to the difficulty, making it almost impossible to establish a standardised measurement of the level of driving or restraining forces being imposed to or received by individual person or organisation.

After reviews of the various models and theories, viz. Force Field Model, the theories of disciplinarity, multidisciplinarity, interdisciplinarity and transdisciplinarity, and emergent approach, I gather that it would not be realistic to develop a comprehensive and holistic framework to be adopted by all different organisations or personnel, each at different levels with different responsibilities or status. Instead, a practical approach should be adopted. The practical approach adopted is to encapsulate the findings from the research, supplemented with the researcher's own knowledge in the field, and then establish a structured framework for guiding and leading the Framework users to review and plan for appropriate actions. In this regard, in line with the "APDRA" (**A**ssess- **P**lan – **D**o – **R**eassess – **A**ct/Adjust) cycle defined for this research project, the functions of the proposed Framework concentrate on the part on review and assessment, leaving the users to review and develop the action plans that they consider to be appropriate.

The adoption of the practical approach has enabled successful completion of the Framework and achievement of the intended objective in concluding the results of the findings of the research and has also made the Framework practical for use. Also, with the aid of the structured configuration of the Framework and its assessment capabilities, the targets to be achieved for effective and efficient BIM implementation could be set, and appropriate assessments of the achievements could be devised. It is perceived that after application of the Framework, the processes for achieving successful BIM implementation and maximising the potential benefits after adoption of BIM could be improved. In short, the objectives of the research project have been achieved and that the targeted contributions to the construction industry have also been realised. Furthermore, applications of the "APDRA" processes and the Change Management Framework would not be

confined to BIM adoptions only but could also be used as the basis for management of other changes. Similar to BIM, the framework could be used as a platform for adopting new technologies or processes, such as Modular Integrated Construction (MiC), Digital Twins, Internet of Things (IoT), Internet of Everything (IoE), Building Operations Optimization (BOO), Information and Communications Technology (ICT), or even Artificial Intelligence (AI), Block Chain, etc.

Another contribution of the Framework would be its capability to blend the technological and non-technological factors. Since the Framework users would mainly be people dealing with "technical" tasks, their concern and requirements on technical aspects must be covered. However, if only the technical issues are resolved, still the changes could not be implemented effectively. Deal consideration of non-technical issues have to be taken. Both types of issues have been incorporated in the Framework for users to review, assess, plan and take appropriate actions. With this dual mode and comprehensive consideration, the Framework would enable the users to implement the change for the adoption of BIM, or other new technologies or processes, in an effective and efficient manner.

6.4 Limitations and Future Research

Within any research project there will always be limitations. For this research project, the scope of investigation and analysis in the context of change management is mainly localized. Some of the factors and environments beyond Hong Kong with related impacts or influences have also been addressed briefly. The context of the study is therefore mainly local and it is expected that through the application of the Framework in other geographical regions with different conditions or environments, more external factors and influencing forces could be revealed.

Furthermore, given the varied nature and conditions of the requirements, resources and in particular the intended targets, straight comparisons of the assessment results for different persons or organisations obtained from the Framework would pose a risk. The Framework is therefore, at this stage, appropriate for being applied for the same person, or persons within the same organisation only. The assessments from the Framework would be applicable for benchmarking the achievements of an individual or organisation, but not for benchmarking amongst different parties.

For future research, the Framework established in this research project could form a good foundation to be extended for making comparisons cross organisations or regions. This would require more substantial research on the major factors in a global manner for incorporation in the framework as enrichment. After that, the extended Framework could be used for more extensive case studies to derive results in forming a larger dataset. Such database could be analysed with the objective to formulate appropriate benchmark indices. These benchmark indices would line up the assessment results to a well-balanced platform for fair and meaningful comparisons, thus facilitating world-wide change implementations for Building Information Modelling adoption.

6.5 Reflection

Many reflections have already been incorporated in previous chapters, alongside with the developments at the various stages. This would be the final and concluding one.

This research project, to me is not only a research or personal development journey but a project with the most hardship but also with the largest reward that I have ever had in my professional life. For the research project, I have to learn and to follow requirements in the academic path and change

substantially the normal but proven to be successful approaches in handling and solving tasks in practice. This change is extremely difficult for a practitioner, in particular a person who has been buried in practical works for so many years. However, the research processes have directed me to a new path of reviewing, exploring and investigating the knowledge areas in a much deeper and wider extent. Coupled with this newly learned knowledge, the research project gives me the opportunity to use my experience and knowledge to realise my intended contribution to the construction industry.

After completion of the research processes, I find myself getting closer to the solutions of the challenges, much better equipped and have more confidence to continue in promoting change, not only for adoption of Building Information Modelling, but also other technological and non-technological aspects in the construction industry, regardless of its complex environment and complicated nature.

In the journey of the Doctorate of Professional Studies programme, I discover that the reflections I have presented are not only useful in doing the research but also applicable in bettering my daily works. For example, when there are resistances from people in change implementations for adopting newly established procedures, instead of requesting them for adoption strictly, I would firstly carry out a comprehensive review and analysis of the change factors, including those related to both technical and non-technical aspects. By doing this, I would be able to have a comprehensive view of the "Subject Substances", including their properties, that causing the influence. More importantly, after such change factor analysis, I would be able to identify the "Object Substance" being influenced, how they are being influenced, and what are the other "Subject Substance" that causing influences, etc. These would not only enable planning and establishment of pathways for effective change implementation, but also facilitate preparation of guidelines and procedures to assist the people affected in adopting the changes.

In conclusion, the process of studying and researching, as a professional worker and a student in the University, has offered me a platform to increase my insights both in the academic as well as the professional world. I now feel that I respect my co-workers and colleagues more as professional entities, as well as individuals with distinct preferences and ways of working. This, in turn has made me evaluate my work's issues not as paradoxes but as challenges that require cooperation, productive partnerships, and the acquisition of solutions. I therefore feel more wholesome as a professional and individual.

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Appendices

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Appendix 1: Information Inadequacy – The Intractable and Untied Knot

This appendix mainly covers extracts of my presentations related to information, such as its nature, the causes and rationale behind the information losses etc. While these issues ought to be and have been taken into consideration in the development of the change management framework, for some of the readers or framework users, these details might be found to be too complicated. For clarity, these extracts are separately included as an appendix so that readers might choose to skip them or read them in-depth later.

Information Losses Categories

In the asset life cycle, there would be different types of information losses but could be categorised under the following:

- Inadequate: the information provided are incomplete, not fulfilling all the requirements of the recipients
- Not the required one: the information provided are only useful to some of the parties but not all
- Not updated: information provided is not updated according to the revisions made
- Not linked to the right item: this differ from the non-updating issue as the information provided might be correct and updated but not for the appropriate item, e.g. the specification provided for window type A is actually for window type B
- Blocked: the information is not transmitted to the recipient properly, or not in a timely manner

Figure 6-1 would help to summarise the information loss problems mentioned above:

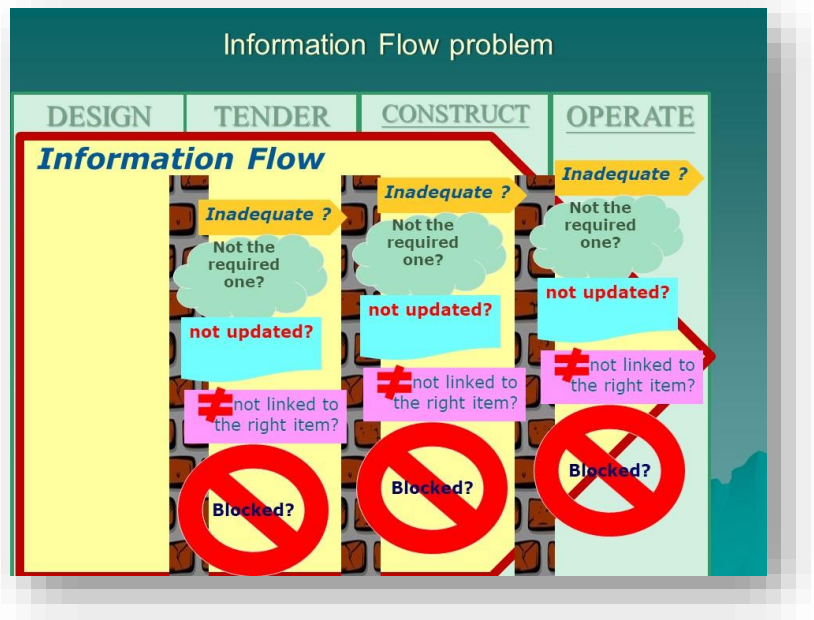


Figure 6-1 Information Flow Problem

Information Gaps

As a result, there are gaps in information at each of the stages, resulting in wider and wider gaps in the "required" realm and the reality realm with provided/received information:

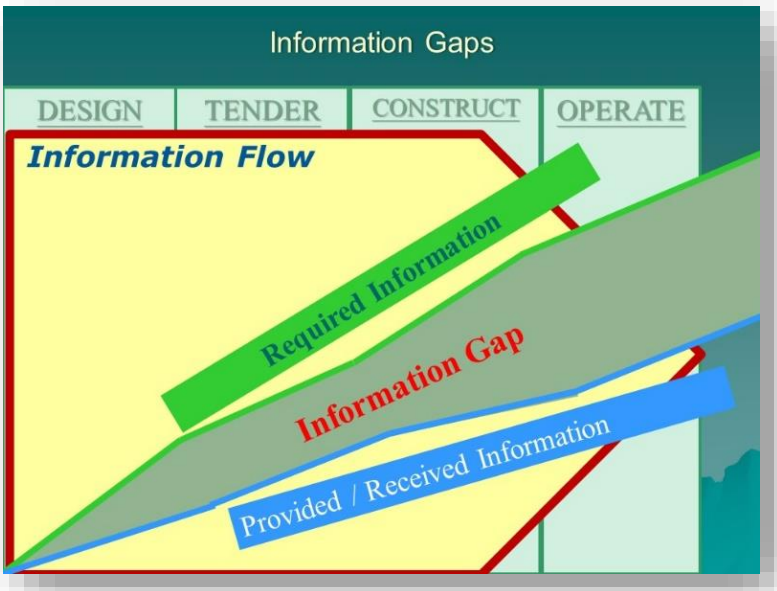


Figure 6-2 Information Gaps in Asset Life Cycle

It is anticipated should the "Information Gap" be closed or reduced, there would be consequent savings in terms of cost and time.

While there is no actual supporting data that could be quoted for the actual savings obtained from closing the gap, the following could be used as a basis for the anticipated benefits, based on the projects that I have handled:

Cost: in general, an allowance of 5% of the works value would be made as contingency to cater for variations and works due to unforeseen site conditions etc. If 20% of this allowance could be saved due to a closed/reduced information gap, the amount would be at 5% x 20% = 1% saved. The saving for the work I have handled would already be HK$11,000 million x1% = HK$110 million, i.e. about £11 million, or USD14 million.

In terms of **time**, based on a normal life cycle of 6 years per capital project and 6 months for each alterations and additions projects, the total duration of the works I have handled is 864 months (12 capital projects x 6 years x 12 months) + 2,100 months (350 alterations project x 6 months) = 2,964 months. Based on the sane saving of 1% as mentioned about, the time saved for the projects I have handled would be around 30 months!

The above figures might not sound substantial but should the anticipated saving of 1% be applied to the annual construction value of $147,000 million in Hong Kong in the past four years, as mentioned in Chapter 1: Project Introduction, Background and Context above, the saving in terms

of cost would become HK$1,470 per annum (i.e., about £147 million, or USD 188 million per annum).

Based on the average cost of HK$600 million per project, the number of projects per annum would be $147,000 million ÷ $600 million = 245 projects. The time involved would be 245 projects x 6 years x 12 months = 17,640 months. The 1% saving would be 176 months of project delivery time. Note that this would be a saving annually!

Therefore, the benefits for the gap closing would be quite a substantial one in terms of both cost and time!

The opportunity for enabling gap closing

In line with the introduction of Building Information Modelling (BIM) concept, models in object types, of three-dimensional nature, would be produced. As each of the objects would has its own identity, and could be embedded with its own properties, the information provided would not be lost and could be easily retrieved correctly. Information changes due to any amendment or updating of the model could be updated immediately and shared/used by all the parties at the same time, without any time lag.

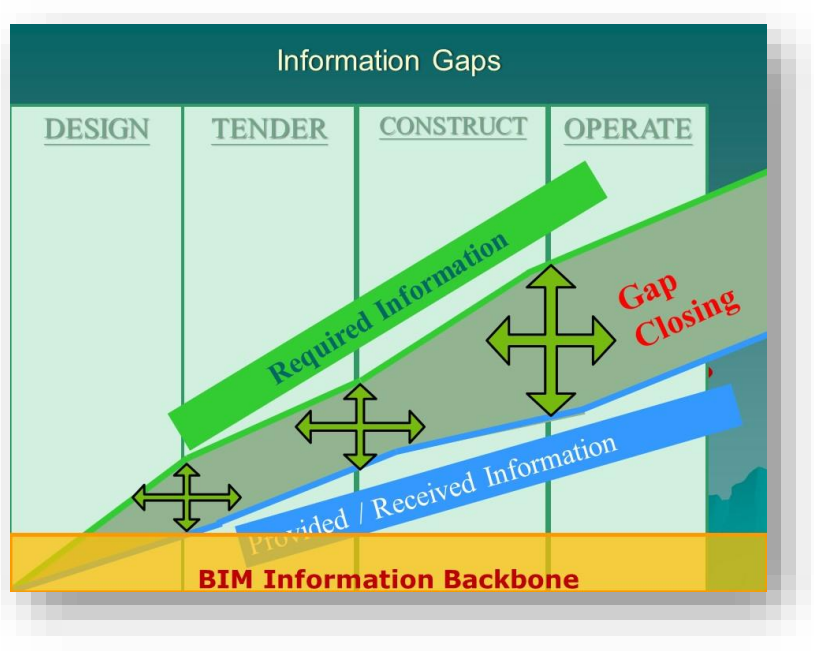
This above could be further illustrated by the history of the software Revit, which is presently the most dominating software for preparing BIM models:

"From the outset, Revit was intended to allow architects and other building professionals to design and document a building by creating a parametric three-dimensional model that included both the geometry and non-geometric design and construction information…. The ease of making changes inspired the name Revit, a contraction of Revise-Instantly."

Source : https://en.wikipedia.org/wiki/Autodesk_Revit#History

So, "Revit" = "Revise Instantly", so that all the necessary revision would be done simultaneously, eliminating the risk of errors due to non-updating.

On the other hand, should there be any inadequacy or inaccuracy in the information provided, the users could trace them easily, channel the findings to the providers and request for rectification. In this regard, the information gap issue could hopefully be closed.



While it is difficult, if not impossible, to have the dream in closing the information gap to become true, the necessity is there to have it realised. In the capacity of a professional member in the construction industry with most of my duties in handling information and the responsibility in ensure projects with good time, cost and quality, the dream is in fact not only a personal wish, but a kind of obligation to the industry as a whole.

Appendix 2 : List of candidate's professional qualifications, major committee/ office holdings, contributions and presentations

Name: Low, Hon Wah

Student ID: M00461240

Professional Qualifications

MHKIBIM Professional Member of the Hong Kong Institute of Building Information Modelling 2018

MbSHK Founding Member and Member of buildingSMART Hong Kong (bSHK) since 2013

F.PFM Fellow Member of the Hong Kong Institute of Facility Management since 2002

MHKCS Corporate Member of the Hong Kong Computer Society since 1996

FRICS Fellow of the Royal Institution of Chartered Surveyors, RICS, Fellow since 1999, Professional Member since 1984

FHKIS Fellow of the Hong Kong Institute of Surveyors, HKIS, Fellow since 1999, Professional Member since 1985

RPS(QS/PFM) Registered Professional Surveyor (Quantity Surveying, Property and Facility Management), under the *Surveyors Registration Ordinance* (Cap. 417)

Major Committee/ Office Holdings

Council Member of the Quantity Surveyor Division, the Hong Kong Institute of Surveyors, 1998 and 1999;

Council Member of the Hong Kong Institute of Facility Management from 2004 to 2011, Hon Secretary (2011/12), Vice-President (2012/13)

Founding member and Hon Secretary of buildingSMART Hong Kong (2012 to 2015), Executive Committee member (2015/17, 2017/19)#

Chairman of the Education and Training Committee, buildingSMART Hong Kong (2013/15);

President, The Hong Kong Institute of Facility Management (2013/14 and 2014/15)

Director of Education and Membership, The Hong Kong Institute of Facility Management 2015/16, 2016/17, 2017/18#

Honorary President (External Operation), Committee of Facility Management, The Institute of Certified Management Accountants Hong Kong Office, 2017/18#

Vice Chair, Global BIM Centre of Excellence, Hong Kong, 2017/18[#]

《中國建設報·中國物業》智庫專家 2018/20 (Member of "Expert Think Tank of China Construction", News·China Property, China 2018/20)[#]

[#] *denotes institutions that I would continue to serve in the coming years*

Major Contributions to the Construction Profession

Visiting lecturer in the Department of Building and Real Estates and Department of Building Services, The Hong Kong Polytechnic University for Building Information Modelling, contract administration, Facility Management, Service Level Agreement, Quantity Surveying and consultants employment/ management related subjects

Assessors of the Assessment of Professional Competence examinations for the Hong Kong Institute of Surveyors, Royal Institution of Chartered Surveyors and Chartered Institute of Building

Founding member of the first overseas chapter of the International Facility Management Association (IFMA) in 1992

Member of the organising panel for Excellence in Facility Management Award (EFMA), the Hong Kong Institute of Facility Management, from 2012 to 2018

Advisory Panel Member, AutoDesk Hong Kong BIM Awards, from 2012 to 2015

Jury Panel Member, Green Building Award 2014

Academic Committee Member for Advanced Diploma/ Diploma in Facility and Property Management, and Postgraduate Diploma in Facilities Management of the School of Professional and Continuing Education (SPACE), University of Hong Kong, 2014/15, 2015/16, 2016/17 and 2017/18

Major BIM/FM related presentations

"BIM for FM – a Client's Perspective" presented in the Hong Kong Institute of Facility Management -PSDAS Conference, Hong Kong, May 2011

"Future Direction of Information Flow in BIM – Early Involvement and Standardisation of Requirements by the FM Sector" presented in the Autodesk University China 2011 Conference, Beijing, November 2011

Course organiser for Training Courses and Workshops for "Building Information Modeling (BIM) in FM", June 2011; "BIM in Works Procurement & Financial Management" in September and November 2011

Review of Way forward for Facility Management – Building Information Modelling (BIM), Hong Kong Institute of Facility Management (HKIFM) seminar, July 2012

Information Flow in Facility Life Cycle – Review and Prospect, Key Note speech in buildSMART Forum, Korea, April 2013

BIM in FM Review and Foresight, visiting lecture for MSc in Facilities Management, Department Building Services Engineering, The Hong Kong Polytechnic University, March 2014

Integrality and Synthesis of Information in BIM processes, Hong Kong Institute of Surveyors CPD event, June 2014

Planning and implementing sustainable measures into the facility management, BEC Leadership Networking Series, Business Environment Council, June 2014

BIM in FM and its future, Royal Institution of Chartered Surveyors Hong Kong Branch CPD event, May 2015

BIM Implementation processes and barriers – in a client's perspective, Global BIM & Development Workshop Seminar 2015, Global BIM Centre of Excellence, September 2015

BIM Applications in Works Procurement and Financial Management, Comprehensive Certificate Course on Management Accounting and Financial Management for FM Professionals, jointly organized by the Institute of Certified Management Accountants (CMA) and HKIFM, March 2016

Data & Information Management for Infrastructure Asset Management, visiting lecture for MSc in Engineering, Department of Civil Engineering, The University of Hong Kong, February 2016

Implications of developments in BIM on Infrastructure Asset Management, visiting lecture for MSc in Engineering, Department of Civil Engineering, The University of Hong Kong, February 2016

BIM Implementation – processes, issues and way forward, Macau Institution of Engineers CPD event, Macau, June 2016

Identification and management of changes in processes, procedures and systems resulted from BIM implementation, Building Information Modelling (BIM) Implementation 2-Day Short Course, jointly organized by University of Nottingham Malaysia and Global BIM Centre of Excellence, Malaysia, May 2017

BIM and Facility Management, Comprehensive Certificate Course on Facility Maintenance & Renovation for FM Professionals, HKIFM, June 2017

Tender Evaluation of Service Level Based Contracts, visiting lecture for MSc in Facility Management offered by Department of Building Services Engineering, The Hong Kong Polytechnic University, November 2017

Data & Information Management for Infrastructure Asset Management – BIM Applications & Implications, visiting lecture for MSc in Engineering, Department of Civil Engineering, The University of Hong Kong, February 2018

"Better Information Management for Costing", joint paper with Lam OW et al., Eighth International Conference on the Constructed Environment, Wayne State University, Detroit, USA, May 2018

Appendix 3: Listing of Major Projects Handled

The following is the list of the major projects handled during the later stage of my career, which would illustrate the diversity, variety, complexity of works extent and nature covered.

Capital Development Projects

A total of 12 major capital projects have been handled, they are:

- Academic / Laboratory/ Office buildings: Phase 6, Phase 7 and Phase 8 Developments, Innovation Tower, and Hong Kong Community College at Hunghom and West Kowloon, altogether with a total gross floor area about 150,000 m2
- Domestic building: Student Hostels Phase 1, 2 and 3, and Senior Staff Quarter; total area about 100,000 m2
- Industrial buildings: Industry Centre Redevelopment and Phase 4; total area about 30,000 m2
- Hotel: Hotel Icon, being part of the Redevelopment of Pak Sui Yuen Project; total area about 18,000 m2
- Performing Arts buildings: Jockey Club Auditorium of about 6,000m2

Total and Averages of the Capital Projects

The total value of these projects account to HK$7,500 million, (i.e. about £750 million, or USD 960 million), with a total area of about 304,000 m2.

Average area per project is around 25,000 m2, with an average cost of HK$600 million (i.e. about £60 million, or USD 77 million) per project.

Alterations and Additions projects

Every year, there have been many alterations, additions and improvement projects with value ranged from HK$1 million to HK$30 million. Taking the global average of say $10 million per project and 10 numbers per year, the total number of projects handled in the year from 1988 to 2018 would be about 350 numbers with the value over HK$3,500 million, i.e. about £350 million, or USD 450 million.

Total Value of projects

The total value of works handled is therefore HK$11,000 million, i.e. about £1,000 million, or USD 1,410 million.

Appendix 4 : Research Ethics form (REf)

Candidates

Your name	Low, Hon Wah
Which programme (MProf or DProf)	DProf
Your adviser's name	Dr Elda Nikolou-Walker
Date of submission	December 2018
Date project commenced	1 January 2019

Declaration

I agree that the REf form attached has been completed accurately to the best of my knowledge at the time.

Candidate signature ..... Date ....

I agree that the attached REf is accurate based on the evidence supplied by the candidate.

Adviser signature..... Date ....

Research Ethics form (REf)

If you place an "X" in any of the white boxes, please provide further information if it is not already contained in your proposal. **Please answer all of these questions.**

Research Ethics form		Yes	No	*NA*
1	Has the draft project proposal and ethical considerations been completed and submitted to the adviser?	X		
Participant's wellbeing				
2	Does your proposed activity involve the participation of human/sentient beings?	X		
3	Have participants been given information about the aims, procedure/processes and possible risks involved in easily understood language?	X		
4	Will any person's position or treatment be in any way prejudiced if they choose not to participate in the project?		X	
5	Can participants freely withdraw from the project at any stage without risk or harm of prejudice?	X		
6	Have all necessary steps been taken to protect the privacy of participants and the need for anonymity?	X		
7	Will the project involve working with or studying minors (under the age of 16 years)?		X	
8	If **Yes**, will signed parental consent be obtained?			*X*
9	Have you considered the ethical implications of selecting data and the obligations to accurately represent participants' views?	X		
Research methods				
10	Are there any questions or procedures likely to be considered in any way offensive or inappropriate?		X	
11	Does your research involve access to confidential/personal records?		X	
12	If **Yes** have you sought permission from the individuals concerned/ followed the protocols required.			*X*

Research Ethics form		Yes	No	*NA*
13	Have you made yourself aware of intellectual property issues regarding any documents, materials you wish to use?	X		
14	Have you clarified with participants the ownership of data?	X		
15	Is there provision for the safekeeping of written data and video/audio recordings of participants?	X		
16	Are there safekeeping strategies for electronic data and correspondence. Refer to the Data Protection Act on keeping personal information on computers.	X		
17	If any specialised instruments, for example psychometric instruments are to be employed, will their use be controlled and supervised by a qualified practitioner, such as a psychologist?			*X*
Effects/Impact				
18	Have you explored the impact of change that may result in your project activity on any participants/people/sentients involved directly or indirectly in the project?	X		
19	If applicable is there provision for debriefing participants after the intervention or project?	X		
20	Have you engaged with your sponsor/employer about any ethics relating to how this research will be used?	X		
Ethical approval from other bodies				
21	Does your project require ethical approval from another body?		X	
22	If **Yes** have the proper approval documents been attached?			*X*
General				
23	Is there any ethical issue/potential issue you have/may have difficulty managing on which you would like more input? If **Yes** please attach a summary		X	

Appendix 5 : Raw data and initial Change Factor Components

The data and the base abstract of the components as conducted in Phases 1 and 2 of Theme Analysis:

		Initial Component Segments			
Context	**Reference**	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC)**
Allow the checking of architectural design of buildings from the sustainability point of view.	(Abolghasemzadeh, 2013)	BIM.	adoption.	checking of design against sustainability.	allowed.
Support collaboration and ease procurement relationships	(Aibinu and Venkatesh, 2014)	BIM.	adoption.	collaboration.	supported.
and ease procurement relationships.	Aibunu and Venkatesh, 2014	BIM.	adoption.	procurement relationship.	eased.
Facilitate support and improve project-related decision-making.	Aibunu and Venkatesh, 2014	BIM.	adoption.	project-related decision-making.	supported and improved.
Enhance innovation capabilities	Aibunu and Venkatesh, 2014	BIM.	adoption.	innovation capabilities.	enhanced.
Encourage the use of new construction methods.	Aibunu and Venkatesh, 2014	BIM.	adoption.	new construction methods.	encouraged.
Emulation of building performance enabled.	(Akinade *et al.*, 2015)	BIM.	adoption.	simulation of building performance.	enabled.
Simulation of energy usage enabled.	Akinada et al., 2015	BIM.	adoption.	Simulation of energy usage.	enabled.
Enhance overall project quality, productivity, and efficiency.	(Akula *et al.*, 2013)	BIM.	integration.	project quality, productivity, and efficiency.	enhanced.

		Initial Component Segments			
Context	**Reference**	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC)**
Reduce safety risks	Akula et al., 2013	BIM.	adoption.	safety risks.	reduced.
Enhance project safety and health performance.	Akula et al., 2013	BIM.	adoption.	project safety and health performance.	enhanced.
Facilitate the selection of sustainable materials and systems for projects.	(Antón and Díaz, 2014)	BIM.	adoption.	selection of sustainable materials and systems for projects.	facilitated.
Higher capacity for accommodating the three pillars of sustainability	Anton and Diaz, 2014	BIM.	adoption.	sustainability capacity.	increased.
Sharing information will provide some direct valuable benefits for the client, specifically full project understanding	(Arayici, 2015)	sharing information.		project understanding.	enhanced.
Ease the integration of sustainability strategies with business planning.	(Autodesk, 2010)	BIM.	adoption.	integration of sustainability strategies with business planning.	eased.
I energy efficiency.	Autodesk, 2010	BIM.	adoption.	energy efficiency.	improved.
Improve resource management.	Autodesk, 2010	BIM.	adoption.	resource management.	improved.
Reduce environmental impact.	Autodesk, 2010	BIM.	adoption.	environmental impact.	reduced.

		Initial Component Segments			
Context	**Reference**	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC)**
Facilitate the selection of sustainable materials and systems for projects.	Autodesk, 2010	BIM.	adoption.	selection of sustainable materials and systems for projects.	facilitated.
Real-time sustainable design and analysis early in the design phase.	(Autodesk, 2011)	BIM.	adoption.	design and analysis.	earlier.
Real-time sustainable design and analysis early in the design phase.	Azhar, 2011 (S Azhar, 2011)	BIM.	adoption.	design and analysis.	earlier.
Clients in particular can achieve worthy benefits on their construction projects by adopting BIM as a process and tool to guide their delivery process to higher quality and performance for a whole building life cycle	Azhar, 2011	BIM adoption.		construction projects.	can achieve high quality.
Enhance overall project quality, productivity, and efficiency.	Azhar, 2011	BIM.	integration.	project quality, productivity, and efficiency.	enhanced.
Schedule compliance in the delivery of construction projects.	Azhar, 2011	BIM.	integration.	delivery of construction projects.	on schedule.

		Initial Component Segments			
Context	**Reference**	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC)**
Improve the operations and maintenance (facility management) of project infrastructure.	Azhar, 2011	BIM.	adoption.	project infrastructure operations and maintenance.	improved.
Better design of products	Azhar, 2011	BIM.	adoption.	design of products.	bettered.
facilitate multi-design alternatives.	Azhar, 2011	BIM.	adoption.	multi-design alternatives.	facilitated.
Control of lifecycle costs	Azhar, 2011	BIM.	adoption.	lifecycle costs.	controlled.
Environmental data.	Azhar, 2011	BIM.	adoption.	environmental data.	controlled.
Facilitate accurate geometrical representations of a building in an integrated data environment.	Azhar, 2011	BIM.	adoption.	accurate geometrical representations of a building in an integrated data environment.	facilitated.
Improve financial and investment opportunities.	(BuySmart Network, 2007)	BIM.	adoption.	financial and investment opportunities.	improved.
Improve financial and investment opportunities.	BuySmart Network, 2007				
Enhance innovation capabilities	BuySmart Network, 2007	BIM.	adoption.	innovation capabilities.	enhanced.
Encourage the use of new construction methods.	BuySmart Network, 2007	BIM.	adoption.	new construction methods.	encouraged.

		Initial Component Segments			
Context	**Reference**	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC)**
Prevent and reduce materials wastage	BuySmart Network, 2007	BIM.	adoption.	materials wastage.	reduced.
Materials reuse and recycling	BuySmart Network, 2007	BIM.	adoption.	materials reuse and recycling.	enabled.
Ensure materials efficiency	BuySmart Network, 2007	BIM.	adoption.	materials efficiency.	ensured.
BIM adoption could be fostered if the Government takes the active role	(Chan, 2014)	Hong Kong Government.	takes the active role.	BIM adoption.	could be fostered.
Chen et al also view that BIM has been under aggressive promotion by governments throughout the world. However, they also pointed out that "By contrast, the Architecture, Engineering, and Construction (AEC) industry shows reluctance to adopt BIM in its projects."	Chen K., Lu W., Peng Y., Zheng L., Niu Y., 2017	AEC industry.	shows reluctance to adopt BIM.	BIM implementation.	hindered.
Facilitate multi-design alternatives.	(Construction Users Roundtable, 2010)	BIM.	adoption.	multi-design alternatives.	facilitated.
Better design of products	Construction Users Roundtable, 2010	BIM.	adoption.	design of products.	bettered.
Facilitate support and improve project-related decision-making.	Construction Users Roundtable, 2010	BIM.	adoption.	project-related decision-making.	supported and improved.
Predictive analysis of performance	(Eastman, 2008)	BIM.	adoption.	performance analysis.	predictive.

		Initial Component Segments			
Context	**Reference**	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC)**
(energy analysis, code analysis).					
Reduced claims or litigation risks.	Eastman, 2008	BIM.	adoption.	claims.	reduced.
Reduced claims or litigation risks.	Eastman, 2008	BIM.	adoption.	litigation.	reduced.
Better design of products	Eastman, 2008	BIM.	adoption.	design of products.	bettered.
facilitate multi-design alternatives.	Eastman, 2008	BIM.	adoption.	multi-design alternatives.	facilitated.
Enhance overall project quality, productivity, and efficiency.	(Hanna, Boodai and Asmar, 2013)	BIM.	integration.	project quality, productivity, and efficiency.	enhanced.
Reduction in the cost of as-built drawings.	Hanna, Boodai and Asmar, 2013	BIM.	adoption.	as-built drawings cost.	reduced.
Reduction in site-based conflicts.	Hanna, Boodai and Asmar, 2013	BIM.	adoption.	site-based conflicts.	reduced.
Prevent and reduce materials wastage	Hanna, Boodai and Asmar, 20132013	BIM.	adoption.	materials wastage.	reduced.
materials reuse and recycling	Hanna, Boodai and Asmar, 2013	BIM.	adoption.	materials reuse and recycling.	enabled.
Ensure materials efficiency	Hanna, Boodai and Asmar, 2013	BIM.	adoption.	materials efficiency.	ensured.
Facilitate resources planning and allocation.	(Hua, 2013)	BIM.	adoption.	resources planning and allocation.	facilitated.
Increased building performance and Quality	(Jones and Bernatein, 2014)	BIM adoption.		building.	performance increased.

		Initial Component Segments			
Context	**Reference**	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC)**
Earlier and more accurate visualization of a design	Jones and Bernatein, 2014	BIM adoption.		design.	earlier and more accurate visualization.
Generation of Accurate and Consistent 2D drawings at any stage of the design	Jones and Bernatein, 2014	BIM adoption.		2D drawing generation.	more accurate and consistent.
Earlier collaboration of Multiple Design Disciplines	Jones and Bernatein, 2014	BIM adoption.		multiple design discipline collaboration.	realise earlier.
BIM will reduce waste (materials, resources & cost) through improved designs and construction processes	Jones and Bernatein, 2014	design and construction processes.	improved.	waste.	will be reduced.
Facilitate integration with domain knowledge areas in project management, safety, sustainability etc	(Abdirad and Pishdad-Bozorgi, 2014)	BIM.	adoption.	domain knowledge integrations.	facilitated.
The collaboration among stakeholders will expand the client's organisational boundaries	(Love *et al.*, 2013)	collaboration.	increased.	client's organisational boundaries.	expand.
Increased performance of the project during different stages of the life cycle	Love et al., 2013	client's organisational boundaries.	expanded.	project performance.	increased.

		Initial Component Segments			
Context	**Reference**	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC)**
Ease the process to obtain building plan approvals and construction permits.	(McGraw-Hill Construction, 2009)	BIM.	adoption.	obtain building plan approval process.	eased.
BIM visualization to enable better understanding of design	(Pittard and Sell, 2016)	BIM visualization.			better understanding.
Fewer problems during construction from deficient documents or coordination	Pittard & Sell 2016	BIM adoption.		construction document or coordination problem.	reduced.
More well-reasoned design due to BIM analysis and simulation	Pittard & Sell 2016	BIM analysis and simulation function.		design.	better reasoned.
Many of the parties involved are still finding their feet in and industry where BIM compliance can bring great rewards.	Pittard & Sell 2016	parties in the industry.	have doubts on benefit.	BIM adoption pace.	has been sluggish.
Many of the parties involved are still finding their feet in and industry where BIM compliance can bring great rewards.	Pittard & Sell 2016				
Many of the parties involved are still finding their feet in and industry where BIM compliance	Pittard & Sell 2016				

		Initial Component Segments			
Context	**Reference**	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC)**
can bring great rewards.					
Increases firms' capability to comply with prevailing statutory regulations.	(Rogers, 2016)	BIM.	adoption.	capability in complying statutory regulation.	increase.
Facilitate building layout flexibility and retro fitting.	(Webster and Costello, 2005)	BIM.	adoption.	retro fitting.	facilitated.
Facilitate building layout flexibility and retro fitting.	Webster and Costello, 2005	BIM.	adoption.	retro fitting.	facilitated.
Facilitate sharing, exchange, and management of project information and data.	(Wong *et al.*, 2014)	BIM.	adoption.	project information sharing, exchange and management.	facilitated.
Facilitate the implementation of green building principles and practices.	(Wu and Issa, 2013)	BIM.	adoption.	Green building principle and practices implementation.	facilitated.

Appendix 6 : Results of the first round review and analysis

	First Round Review and Analysis Results			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC**
Allow the checking of architectural design of buildings from the sustainability point of view.	BIM Model	visualisation capability	checking of design against sustainability	enabled
Support collaboration and ease procurement relationships	BIM process	collaboration capability	ease in collaboration of works activities	increased
and ease procurement relationships.	BIM process	integration capability	ease in procurement	increased
Facilitate support and improve project-related decision-making.	BIM Model	visualisation capability	ease in project-related decision-making	increased
Enhance innovation capabilities	BIM Model	visualisation capability	innovative proposal capability	increased
Encourage the use of new construction methods.	BIM Model	visualisation capability	use of new construction methods	encouraged
Emulation of building performance enabled.	BIM Model	visualisation capability	simulation of building performance	enabled
Simulation of energy usage enabled.	BIM Model	visualisation capability	Simulation of energy usage	enabled
Enhance overall project quality, productivity, and efficiency.	BIM model	integration capability	works efficiency	enhanced
Reduce safety risks	BIM model	visualisation capability	site safety risk	reduced
Enhance project safety and health performance.	BIM model	visualisation capability	safety and health performance	enhanced

	First Round Review and Analysis Results			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC**
Facilitate the selection of sustainable materials and systems for projects.	BIM process	enhance product design capability	selection of sustainable materials	facilitated
Higher capacity for accommodating the three pillars of sustainability	BIM process	enhance product design capability	sustainability capacity.	increased
Sharing information will provide some direct valuable benefits for the client, specifically full project understanding	BIM process	sharing information capability	ease in understanding project requirements	enhanced
Ease the integration of sustainability strategies with business planning.	BIM model	integration capability	implementation of green principle and practices	facilitated
Improve energy efficiency.	BIM model	visualisation capability	energy efficiency performance	increased
Improve resource management.	BIM process	data management capability	resources management	improved
Reduce environmental impact.	BIM Model	visualisation capability	adverse impact on environment	reduced
Facilitate the selection of sustainable materials and systems for projects.	BIM process	enhance product design capability	selection of sustainable materials	facilitated
Real-time sustainable design and analysis early in the design phase.	BIM Model	visualisation capability	Timing for design analysis	advanced

	First Round Review and Analysis Results			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC**
Real-time sustainable design and analysis early in the design phase.	BIM model	visualisation capability	design and construction processes	improved
Clients in particular can achieve worthy benefits on their construction projects by adopting BIM as a process and tool to guide their delivery process to higher quality and performance for a whole building life cycle	BIM process	guidance capability	construction projects quality level	raised
Enhance overall project quality, productivity, and efficiency.	BIM model	integration capability	project quality	enhanced
Schedule compliance in the delivery of construction projects.	BIM model	integration capability	construction works timing	improved
Improve the operations and maintenance (facility management) of project infrastructure.	BIM process	asset lifelong coverage	operations and maintenance performance	improved
Better design of products	BIM Model	visualisation capability	product design performance	increased
facilitate multi-design alternatives.	BIM Model	visualisation capability	ease in proposing multi-design alternatives	increased
Control of lifecycle costs	BIM process	asset lifelong coverage	control of lifecycle costs	improved
Environmental data.	BIM process	asset lifelong coverage	management of environmental data	improved

	First Round Review and Analysis Results			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC**
Facilitate accurate geometrical representations of a building in an integrated data environment.	BIM Model	parameters embedding with objects capability	data integration	facilitated
Improve financial and investment opportunities.	BIM Model	visualisation capability	Analysis of financial and investment opportunities	improved
Improve financial and investment opportunities.				
Enhance innovation capabilities	BIM Model	visualisation capability	innovative proposal capability	increased
Encourage the use of new construction methods.	BIM Model	visualisation capability	use of new construction methods	encouraged
Prevent and reduce materials wastage	BIM model	visualisation capability	wastage of materials	reduced
materials reuse and recycling	BIM model	visualisation capability	reuse and recycling of materials	enabled
ensure materials efficiency	BIM model	visualisation capability	efficiency in materials usage	ensured
BIM adoption could be fostered if the Government takes the active role	Government	active role taking	use adoption	fostered

	First Round Review and Analysis Results			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC**
Chen et al also view that BIM has been under aggressive promotion by governments throughout the world. However, they also pointed out that "By contrast, the Architecture, Engineering, and Construction (AEC) industry shows reluctance to adopt BIM in its projects."	AEC industry.	resistance in adoption	implementation progress	hindered.
facilitate multi-design alternatives.	BIM Model	visualisation capability	ease in proposing multi-design alternatives	increased
Better design of products	BIM Model	visualisation capability	product design performance	increased
Facilitate support and improve project-related decision-making.	BIM Model	visualisation capability	ease in project-related decision-making	increased
Predictive analysis of performance (energy analysis, code analysis).	BIM model	visualisation capability	predictive analysis	enabled
Reduced claims or litigation risks.	BIM Model	clash detection capability	amount of contractual claims	reduced
Reduced claims or litigation risks.	BIM Model	clash detection capability	risk in litigation	reduced
Better design of products	BIM Model	visualisation capability	product design performance	increased

	First Round Review and Analysis Results			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC**
facilitate multi-design alternatives.	BIM Model	visualisation capability	ease in proposing multi-design alternatives	increased
Enhance overall project quality, productivity, and efficiency.	BIM model	integration capability	works productivity	enhanced
Reduction in the cost of as-built drawings.	BIM Model	visualisation capability	cost for preparing as built drawings	reduced
Reduction in site-based conflicts.	BIM Model	clash detection capability	site based conflicts	reduced
Prevent and reduce materials wastage	BIM model	visualisation capability	wastage of materials	reduced
materials reuse and recycling	BIM model	visualisation capability	reuse and recycling of materials	enabled
ensure materials efficiency	BIM model	visualisation capability	efficiency in materials usage	ensured
Facilitate resources planning and allocation.	BIM Process	asset lifelong coverage	facilities resources planning performance	improved
Increased building performance and Quality	BIM process	integration capability	building performance quality	increased
Earlier and more accurate visualization of a design	BIM model	visualisation capability	design accuracy	increased

	First Round Review and Analysis Results			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC**
Generation of Accurate and Consistent 2D drawings at any stage of the design	2D drawing for approval	obligatory	implementation process	hindered
Earlier collaboration of Multiple Design Disciplines	BIM process	collaboration facilities	multiple design discipline collaboration process time	shortened
BIM will reduce waste (materials, resources & cost) through improved designs and construction processes	BIM model	visualisation capability	waste generation	reduced
Facilitate integration with domain knowledge areas in project management, safety, sustainability etc	BIM process	data management capability	domain knowledge integrations	facilitated
the collaboration among stakeholders will expand the client's organisational boundaries	BIM process	collaboration capability	client's organisational boundaries.	expanded
increased performance of the project during different stages of the life cycle	BIM process	collaboration capability	project performance level	raised
Ease the process to obtain building plan approvals and construction permits.	BIM Model	clash detection capability	Ease in obtaining approvals	increased
BIM visualization to enable better understanding of design	BIM model	visualization capability	ease in understanding of design	bettered

	First Round Review and Analysis Results			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC**
Fewer problems during construction from deficient documents or coordination	BIM process	integration ability	construction document or coordination problems	reduced
More well-reasoned design due to BIM analysis and simulation	BIM software	analysis and simulation capability	design reasoning	bettered
many of the parties involved are still finding their feet in and industry where BIM compliance can bring great rewards	parties in the industry	doubts on benefit	adoption pace	sluggish
many of the parties involved are still finding their feet in and industry where BIM compliance can bring great rewards				
many of the parties involved are still finding their feet in and industry where BIM compliance can bring great rewards				
Increases firms' capability to comply with prevailing statutory regulations.	BIM Model	clash detection capability	capability in complying prevailing statutory regulations	increased
Facilitate building layout flexibility and retro fitting.	BIM Model	visualisation capability	flexibility in building layout design	increased
Facilitate building layout flexibility and retro fitting.	BIM Model	visualisation capability	flexibility in fitting out design for	increased

	First Round Review and Analysis Results			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Object Substance (OS)**	**Change on Object Substance (OC**
			existing buildings	
Facilitate sharing, exchange, and management of project information and data.	BIM Model	information sharing capability	ease in exchange of project information	increased
Facilitate the implementation of green building principles and practices.	BIM model	visualisation capability	implementation of green principle and practices	facilitated

Appendix 7 : The Final Round Analysis Results with Labelling of Keywords

	Final Round Analysis Results with Labelling of Keywords			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Change on Object Substance (OC)**	**Object Substance (OS)**
Allow the checking of architectural design of buildings from the sustainability point of view.	BIM Model	visualisation capability	improve	design process
Support collaboration and ease procurement relationships	BIM Process	collaboration capability	improve	collaboration process
and ease procurement relationships.	BIM Process	integration capability	improve	procurement process
Facilitate support and improve project-related decision-making.	BIM Model	visualisation capability	improve	decision-making process
Enhance innovation capabilities	BIM Model	visualisation capability	enhance	innovative proposal capability
encourage the use of new construction methods.	BIM Model	visualisation capability	encourage	new method adoption
emulation of building performance enabled.	BIM Model	visualisation capability	improve	building performance simulation process
Simulation of energy usage enabled.	BIM Model	visualisation capability	improve	energy usage simulation process
Enhance overall project quality, productivity, and efficiency.	BIM Process	integration capability	improve	works process
Reduce safety risks	BIM Model	visualisation capability	reduce	site safety risk
enhance project safety and health performance.	BIM Model	visualisation capability	improve	safety and health performance

	Final Round Analysis Results with Labelling of Keywords			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Change on Object Substance (OC)**	**Object Substance (OS)**
Facilitate the selection of sustainable materials and systems for projects.	BIM software	design function	improve	sustainable material selection process
Higher capacity for accommodating the three pillars of sustainability	BIM software	design function	improve	sustainability performance
sharing information will provide some direct valuable benefits for the client, specifically full project understanding	BIM Model	information sharing capability	improve	project requirements understanding process
Ease the integration of sustainability strategies with business planning.	BIM Process	integration capability	improve	green implementation process
improve energy efficiency.	BIM Model	visualisation capability	increase	sustainability performance
Improve resource management.	BIM Process	data management capability	improve	resources management
Reduce environmental impact.	BIM Model	visualisation capability	improve	environmental protection performance
Facilitate the selection of sustainable materials and systems for projects.	BIM Software	design function	improve	sustainable material selection process
Real-time sustainable design and analysis early in the design phase.	BIM Model	visualisation capability	improve	design analysis process
Real-time sustainable design and analysis early in the design phase.	BIM Model	visualisation capability	improve	design process
	BIM Model	visualisation capability	improve	construction processes

	Final Round Analysis Results with Labelling of Keywords			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Change on Object Substance (OC)**	**Object Substance (OS)**
Clients in particular can achieve worthy benefits on their construction projects by adopting BIM as a process and tool to guide their delivery process to higher quality and performance for a whole building life cycle	BIM Process	guidance capability	improve	project quality
Enhance overall project quality, productivity, and efficiency.	BIM Process	integration capability	improve	project quality
Schedule compliance in the delivery of construction projects.	BIM Process	integration capability	reduce	works processes
Improve the operations and maintenance (facility management) of project infrastructure.	BIM process	asset lifelong coverage	improve	built asset performance
Better design of products	BIM Software	design function	improve	design performance
facilitate multi-design alternatives.	BIM Software	design function	improve	alternatives design process
Control of lifecycle costs	BIM process	asset lifelong coverage	improve	control of lifecycle costs
environmental data.	BIM process	asset lifelong coverage	improve	management of environmental data
Facilitate accurate geometrical representations of a building in an integrated data environment.	BIM Process	data management capability	improve	data integration process

	Final Round Analysis Results with Labelling of Keywords			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Change on Object Substance (OC)**	**Object Substance (OS)**
Improve financial and investment opportunities.	BIM Model	visualisation capability	increase	financial opportunities
Improve financial and investment opportunities.	BIM Model	visualisation capability	increase	investment opportunities
Enhance innovation capabilities	BIM Model	visualisation capability	increase	innovative proposal capability
encourage the use of new construction methods.	BIM Model	visualisation capability	increase	new method adoption
Prevent and reduce materials wastage	BIM Model	visualisation capability	reduce	wastage output
materials reuse and recycling	BIM Model	visualisation capability	reduce	wastage output
ensure materials efficiency	BIM Model	visualisation capability	reduce	wastage output
BIM adoption could be fostered if the Government takes the active role	Government leadership	Activeness	speed up	BIM adoption pace
Chen et al also view that BIM has been under aggressive promotion by governments throughout the world. However, they also pointed out that “By contrast, the Architecture, Engineering, and Construction (AEC) industry shows reluctance to adopt BIM in its projects.”	construction industry	Adoption resistance	slow down	BIM implementation pace

	Final Round Analysis Results with Labelling of Keywords			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Change on Object Substance (OC)**	**Object Substance (OS)**
facilitate multi-design alternatives.	BIM Model	visualisation capability	improve	alternatives design process
Better design of products	BIM Model	visualisation capability	improve	design performance
Facilitate support and improve project-related decision-making.	BIM Model	visualisation capability	improve	decision-making process
Predictive analysis of performance (energy analysis, code analysis).	BIM Model	visualisation capability	improve	predictive analysis
Reduced claims or litigation risks.	BIM Model	clash detection capability	reduce	contractual claims
Reduced claims or litigation risks.	BIM Model	clash detection capability	reduce	litigation risk
Better design of products	BIM Model	visualisation capability	improve	design performance
facilitate multi-design alternatives.	BIM Model	visualisation capability	improve	alternatives design process
Enhance overall project quality, productivity, and efficiency.	BIM Process	integration capability	increase	works process
Reduction in the cost of as-built drawings.	BIM Model	visualisation capability	decrease	as built drawings preparation cost
Reduction in site-based conflicts.	BIM Model	clash detection capability	improve	works processes
Prevent and reduce materials wastage	BIM Model	visualisation capability	reduce	wastage output
materials reuse and recycling	BIM Model	visualisation capability	reduce	waste output
ensure materials efficiency	BIM Model	visualisation capability	reduce	wastage output

	Final Round Analysis Results with Labelling of Keywords			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Change on Object Substance (OC)**	**Object Substance (OS)**
Facilitate resources planning and allocation.	BIM process	asset lifelong coverage	improve	facilities resources planning performance
Increased building performance and Quality	BIM Process	integration capability	improve	building performance quality
Earlier and more accurate visualization of a design	BIM Model	visualisation capability	increase	design accuracy level
Generation of Accurate and Consistent 2D drawings at any stage of the design	Approval process	traditional approach	slow down	BIM implementation pace
Earlier collaboration of Multiple Design Disciplines	BIM Process	collaboration capability	improve	collaboration process
BIM will reduce waste (materials, resources & cost) through improved designs and construction processes	BIM Model	visualisation capability	reduce	wastage output
Facilitate integration with domain knowledge areas in project management, safety, sustainability etc	BIM Technology	data management capability	improve	data integration process
the collaboration among stakeholders will expand the client's organisational boundaries	BIM Process	collaboration capability	increase	client's market share
increased performance of the project during different stages of the life cycle	BIM Process	collaboration capability	improve	project performance

	Final Round Analysis Results with Labelling of Keywords			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Change on Object Substance (OC)**	**Object Substance (OS)**
Ease the process to obtain building plan approvals and construction permits.	BIM Model	clash detection capability	improve	approval processes
BIM visualization to enable better understanding of design	BIM Model	visualisation capability	improve	understanding design process
Fewer problems during construction from deficient documents or coordination	BIM Process	integration capability	improve	coordination process
More well-reasoned design due to BIM analysis and simulation	BIM software	analysis capability	improve	reasoning design process
many of the parties involved are still finding their feet in and industry where BIM compliance can bring great rewards	construction industry participants	doubts on benefit	slow down	adoption pace
many of the parties involved are still finding their feet in and industry where BIM compliance can bring great rewards	BIM Process	integration capability	improve	documentation process
many of the parties involved are still finding their feet in and industry where BIM compliance can bring great rewards	BIM software	simulation capability	improve	reasoning design process
Increases firms' capability to comply with prevailing statutory regulations.	BIM Model	clash detection capability	improve	statutory approval process

	Final Round Analysis Results with Labelling of Keywords			
Context	**Subject Substance (SS)**	**Subject Attribute (SA)**	**Change on Object Substance (OC)**	**Object Substance (OS)**
Facilitate building layout flexibility and retro fitting.	BIM Model	visualisation capability	improve	layout design process
Facilitate building layout flexibility and retro fitting.	BIM Model	visualisation capability	improve	existing buildings fitting out design process
Facilitate sharing, exchange, and management of project information and data.	BIM Model	information sharing capability	increase	information exchange process
Facilitate the implementation of green building principles and practices.	BIM Model	visualisation capability	improve	green implementation

Appendix 8 - Primary Research Analysis (altogether in three parts)

Appendix 8 - Part (1) : Abstracted Vision, Mission and related Statements

Company	Vision	Mission	Others
AECOM Asia Company Limited	not found	not found	As a fully integrated firm, we connect knowledge and experience across our global network of experts to help clients solve their most complex challenges. From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our work is transformative, differentiated and vital.
Aedas	not found	We create world-class design solutions that are tailored to the needs of cities and communities around the world.	
Airport Authority Hong Kong	To strengthen HKIA as the leading international aviation hub and a key engine for the economic growth of Hong Kong.	To excel in the operation and development of HKIA in collaboration with our partners by: Operating efficiently with care for the environment; Striving to exceed customer expectations; Applying prudent commercial principles; Valuing our people; Fostering a culture of innovation; Upholding high standards in safety and security	

Company	Vision	Mission	Others
Architectural Project Unit Limited			BIM Pioneer APU is one of the pioneers of the region in implementing Building Information Modelling (BIM) in building design and project management. The top-notch technology smooths the design and construction processes by providing comprehensive, efficient and accurate solutions to our clients and other consultants at an early stage.
Architectural Services Department, HKSAR	Serve and care for our community by enriching the living environment through quality professional services.	Ensure the quality, cost effectiveness and sustainable development of community facilities. Ensure the quality and cost effectiveness in the up keeping of community facilities. Provide quality professional advisory services on community facilities and related matters. ·Promote best practices in the building industry.	
arQstudio Limited and AMQ Limited	not found	not found	about us: Furthermore, the studio considers each project as an opportunity for innovation and research, and fully embraces new technology and software such as BIM, sun and wind simulation.

Company	Vision	Mission	Others
ARUP	not found	not found	Fellowships celebrate those at the forefront of excellence at Arup. These individuals exemplify exceptional talent, technical excellence, vision and ingenuity – not just in our firm, but in the world.
ATAL Building Services Engineering Ltd		For us, engineering is a passion. Our motto is "We commit, we perform, we deliver." Whether the challenge is part of a mega-project or a single installation, we approach it with the same tenacity and determination.	
bimSCORE Limited	SBI was founded by Dr. Calvin Kam in 2011 with a vision to optimize the value of the global built environment through continuous improvement in evidence-based business decision-making, performance metrics, best practice processes, sustainability, and appropriate technologies.		

Company	Vision	Mission	Others
Black & Veatch Hong Kong Limited			Culture & Values: As an innovator, collaborator and future maker, Black & Veatch is characterized by curiosity, a trait that helps us find solutions to your most complex challenges. Let’s work together on a better way, and never stop asking, 'what if?' Safety, sustainability and responsibility also are engrained into every Black & Veatch professional, and they’re designed into all projects. Let us show you what it means to put you first.
Chun Wo Construction & Engineering Co., Ltd	To be an acclaimed contractor and developer in Asia with dynamic growth	Improve people's quality of life through city and infrastructure development Grow with our employees through fulfilling work environment and career development Create value for shareholders	
City University of Hong Kong	City University of Hong Kong aspires to become a leading global university, excelling in research and professional education.	To nurture and develop students' talents and to create applicable knowledge for social and economic advancement.	

Company	Vision	Mission	Others
CLP Power Hong Kong Limited	CLP's vision is to be the leading responsible energy provider in the Asia-Pacific region, from one generation to the next.	In a changing world, our mission is to produce and supply energy with minimal environmental impact to create value for shareholders, employees and the wider community	
Construction Industry Council	To drive for unity and excellence of the construction industry of Hong Kong.	To strengthen the sustainability of the construction industry in Hong Kong by providing a communications platform, striving for continuous improvement, increasing awareness of health and safety, as well as improving skills development.	
Continental Engineering Corporation		To become a leader in Asia and beyond, striving for corporate excellence and providing quality professional services in the construction industry.	

Company	Vision	Mission	Others
CR Construction Company Limited	To grow on fifty years of reputation and experiences. To focus on customer's success and satisfaction. To enrich our people's professionalism and quality of services. To optimise effectiveness of management systems. To align partners and stakeholders for better understanding and collaboration. To enhance industry standards and performance.	With Hong Kong as the home base, to be a people-oriented company to drive the construction industry forward	
Dragages Hong Kong Limited		Having grown hand in hand with Hong Kong, our mission remains to deliver all our projects to the highest level of client, staff, shareholder and stakeholder satisfaction	
Drainage Services Department	To provide world-class wastewater and storm water drainage services enabling the sustainable development of Hong Kong	Improving drainage services in a cost-effective and environmentally responsible manner Enhancing a caring, harmonious, safe and healthy work environment that fosters staff development and a mind set for change Strengthening relationships with community, industry	

Company	Vision	Mission	Others
		and worldwide counterparts	
Electrical and Mechanical Services Department - Regulatory Services	Our vision is to be the government agency that makes Hong Kong a top-ranking city in E&M safety and in the utilisation of energy.	Our mission is to enhance the safety and the quality of life of our community by ensuring that E&M and energy technologies are harnessed in a safe, reliable, economical and environment-friendly manner.	
Engineering Surveys Limited	not found	not found	Building Information Modelling is changing the way that building design and construction is conceived and implemented. It also provides a useful tool for surveyors to extract and display spatial data. Engineering Surveys are committed to keeping pace with and adopting such technology anywhere it provides a clear benefit to ourselves or our clients.
Farrells	not found	not found	social commitment: We are committed to driving forward a more sustainable present for a better tomorrow.
Forida Limited	not found	not found	When construction project teams have the right information at the right time, work happens faster. Expertise: We help clients on the long-term strategies, management, staffing and infrastructure on

Company	Vision	Mission	Others
			application of BIM technology.
FSEE	Better Life, Better Home, Better Quality to You Everyday	We offer superior service, we create an integrated, convenient and safe living environment. We are devoted to serve: Customers - We provide customized service and maintain long term partnership. Staff - We promote work-life balance and create a strong sense of belonging. Community - We maintain sustainable development and contribute to community.	
Gammon Construction Ltd	To be the smart and digital contractor of choice in Hong Kong, China and Southeast Asia.	To build for a better quality of life and living environment in a safe and sustainable manner.	At Gammon, our ultimate goal is to deliver a high level of quality to our customers. This means not only the quality of our built products and service outcomes, but also in the way they are delivered: reliably, safely and responsibly.
Hanison Construction Company Limited	To be a renowned, creative and socially responsible building contractor of choice in Hong Kong.	Provide quality products and service with continuous improvement and innovation. Serve our clients with professionalism and build with "heart". Grow with our community in sustainable manner.	

Company	Vision	Mission	Others
		Develop our employees via job satisfaction and career development.	
Henderson (China) Investment Company Limited	not found	not found	Our aim is to add value for our shareholders, customers and the community through a commitment to excellence in product quality and service delivery as well as a continuous focus on sustainability and the environment.
Hip Hing Construction Company Limited	To be the contractor you trust	To build and shape a better living environment To deliver projects that exceed the expectations of our clients To provide rewarding careers and personal development opportunities to our staff	

Company	Vision	Mission	Others
Hong Kong Housing Authority	To provide affordable rental housing to low-income families with housing needs, and to help low to middle-income families gain access to subsidised home ownership.	To provide affordable quality housing, management, maintenance and other housing related services to meet the needs of our customers in a proactive and caring manner. To provide an age-friendly and barrier-free estate environment to address the needs of residents of different ages and physical ability. To ensure cost-effective and rational use of public resources in service delivery and allocation of housing assistance in an open and equitable manner. To maintain a competent, dedicated and performance-oriented team.	
Integrated Design Limited	To be the most reputable Digital Delivery Consultant in Asia.	Engage Clients and Contractors. Automate Workflows and Process.	
isBIM Limited	isBIM insists on innovation-driven development, promoting continuous improvement, and building an integrated knowledge platform that can transform data into a new ecosystem	not found	

Company	Vision	Mission	Others
	to achieve excellence in construction.		
J. Roger Preston Limited	To be the Premier Engineering Services Provider in the South East Asia Region.	To provide quality professional services that meet the needs of our clients	
K C Tang Consultants Limited	not found	not found	Objectives: Provide quality quantity surveying services (construction cost and contract consultancy services). Present to prospective clients that we can provide quality services. Be appointed not because of our fee but because of our service. Understand the clients' needs and the counterparties' difficulties. Help clients forecast, plan, monitor, control and finalize construction costs. Prepare tender documents with sufficient details and unambiguous terms to enable tenderers to adequately price for the works, products and services required. Adopt fair, reasonable and practicable contract terms. Protect the clients' interest but be fair and reasonable to counterparties. Secure the clients' trust and respect of our professional opinion. Act proactively and promptly. Reduce abortive work and wastes. Keep updated with knowledge and technology.

Company	Vision	Mission	Others
			Be appreciated and re-appointed by the same clients. Be satisfied with ourselves.
Kerry Properties Hong Kong Limited	not found	not found	Guided by the principle of aspiring to excellence, Kerry Properties is a world-class property development company with significant investments in key cities in Mainland China and Hong Kong. In both markets, Kerry Properties focuses on investing in premium quality property developments in prime locations. Beyond the developments, the Group continues to serve clients by offering professional management and a range of value-added services and diverse privileges.
Kingsfield Engineering Limited	not found	not found	commitment: Kingsfield assures the highest degree of quality and accuracy to each project. In the early stage of the project, our experienced engineer, CAD draftsperson or BIM modeler will suggest and always comply with the drawing standards and meet requirements by the clients which will be the key to a successful project. Implementing strict Quality Control enables Kingsfield to keep on providing high standard services to clients.

Company	Vision	Mission	Others
LEAD8 Limited	not found	However, this has not dissuaded Lead8 from endeavouring towards its mission to build better communities and commitment to Corporate Social Responsibility.	not found
Leighton Contractors (Asia) Ltd	not found	to generate sustainable returns for our shareholders by delivering projects for our clients while providing safe, rewarding and fulfilling careers for our people.	
Lik Kai Engineering Co. Ltd.	To be a pioneering team in the engineering profession providing innovative total solutions of the highest quality.	Building a better tomorrow	
LWK & Partners (HK) Ltd.	not found	we create world-class design and built solutions that respond to local culture and client needs.	
Mott MacDonald HK Limited	not specifically stated	not specifically stated	Our vision and mission are underpinned by our PRIDE values: We drive change and use it to create opportunity We aim to make a lasting positive difference for present and future generations We actively develop ourselves as individuals and professionals.

Company	Vision	Mission	Others
Mtech Engineering Company Limited	Is to be the mechanical industry design/build leader, locally owned, offering the highest degree of technical and operational efficiency for commercial and industrial projects.		
MTR Corporation Limited	We aim to be a leading multinational company that connects and grows communities with caring service.	We will: strengthen our Hong Kong corporate citizen reputation; grow and enhance our Hong Kong core business; accelerate our success in the Mainland and internationally; inspire, engage and develop our staff.	
New World Construction Company Limited	To build a better society through innovation and sustainable growth	• Commit to long-term value creation for shareholders via sound and visionary leadership • Pioneer a contemporary living culture through the delivery of bespoke products and services • Deliver unique and intriguing customer experiences that cater to their needs • Nurture a professional and intrapreneurial staff force with commitment and pride • Care for our communities and new generation and respect our environment	

Company	Vision	Mission	Others
Ove Arup and Partners HK Ltd	not found	not found	Arup's shared values, like our firm's name, are derived from the beliefs and convictions of our founder, the engineer and philosopher Sir Ove Arup. -- Our work should be interesting and rewarding. Only a job done well, as well as we can do it -- and as well as it can be done -- is that. We must therefore strive for quality in what we do, and never be satisfied with the second-rate.
Penta-Ocean Construction Company Limited	As a leading contractor in coastal and waterfront area, we seek to create attractive environment and pursue customer satisfaction and social contribution as an engineering-oriented company.		
Platform Design Associates Limited	Our vision is to ultimately, through the interdisciplinary approach and creative employment of BIM, transcend the discipline towards Building Information Management - making the technology a decision-making tool.		

Company	Vision	Mission	Others
QnS Consultancy Limited		Our mission is to achieve the objectives of our clients while creating value for them with the professional skills of ours, also to maintain a strong long-term partnership.	
Rider Levett Bucknall Limited	The Rider Levett Bucknall vision is to be the global leader in the market, through flawless execution, a fresh perspective and independent advice.		
Ronald Lu & Partners (HK) Ltd.	Ronald Lu & Partners (RLP) is a design-led architecture firm with a vision to design a better life and redefine sustainability.		
Sane Form Limited		improve architectural designs of landmark buildings using geometric logic	
Summit Technology (Hong Kong Limited)		Be a strategic partner to our clients by providing a total solution in maximizing investment in long run. Acting as a key bridging role in sharing and introducing Autodesk technology to the industry while we strongly believe that cutting edge software solution together with excellent industrial expertise are the	

Company	Vision	Mission	Others
		driving force of industry progression.	
Sun Hung Kai Architects and Engineers Limited		We intend to remain at the forefront of the region's financial services industry by aggressively expanding our customer asset base, investing alongside the Group's expertise to enhance shareholders' and customers' values.	
Swire Properties Limited			Value: Quality is caring about details, recognising the importance of design and superior professionalism in management. We set the highest targets and always aim to exceed expectations. We customise each product to the unique characteristics of its location and aim to create an inspiring, uplifting experience for each and every tenant, visitor, resident and guest. Best-in-class serves only as the baseline from which to improve.
Ten Design	not found	not found	The practice focuses on bringing innovative design solutions for multicultural projects, with economic and social integrity.

Company	Vision	Mission	Others
The Hong Kong University of Science and Technology	To be a leading university with significant international impact and strong local commitment.	To advance learning and knowledge through teaching and research, particularly: – in science, technology, engineering, management and business studies; and – at the postgraduate level; To assist in the economic and social development of Hong Kong.	
The University of Hong Kong	The University of Hong Kong, Asia's Global University, delivers impact through internationalisation, innovation and interdisciplinary. It attracts and nurtures global scholars through excellence in research, teaching and learning, and knowledge exchange. It makes a positive social contribution through global presence, regional significance and engagement with the rest of China.	To advance constantly the bounds of scholarship, building upon its proud traditions and strengths To provide a comprehensive education, benchmarked against the highest international standards, designed to develop fully the intellectual and personal strengths of its students, while extending lifelong learning opportunities for the community To produce graduates of distinction committed to academic/professional excellence, critical intellectual inquiry and lifelong learning, who are communicative	

Company	Vision	Mission	Others
		and innovative, ethically and culturally aware, and capable of tackling the unfamiliar with confidence To develop a collegial, flexible, pluralistic and supportive intellectual environment that inspires and attracts, retains and nurtures scholars, students and staff of the highest calibre in a culture that fosters creativity, learning and freedom of thought, enquiry and expression To provide a safe, healthy and sustainable workplace to support and advance teaching, learning and research at the University To engage in innovative, high-impact and leading-edge research within and across disciplines To be fully accountable for the effective management of public and private resources bestowed upon the institution and act in partnership with the community over the generation, dissemination and application of knowledge To serve as a focal	

Company	Vision	Mission	Others
		point of intellectual and academic endeavour in Hong Kong, China and Asia and act as a gateway and forum for scholarship with the rest of the world Vision 2016-2025	

Company	Vision	Mission	Others
Transport and Housing Bureau			Policy address: continue our efforts in increasing housing supply based on the Long Term Housing Strategy, with a view to addressing the problem of housing supply-demand imbalance; -provide more public rental housing units and ensure the rational use of existing resources; -provide more subsidised sale flats, expand the forms of subsidised home ownership and facilitate market circulation of existing stock; and -maintain the healthy development of the private residential property market, accord priority to meet Hong Kong permanent residents' home ownership needs in the tight supply-demand situation, and promote good sales and tenancy practices for private residential properties at the same time.
Vocational Training Council (VTC)	To be the leading provider of vocational and professional education and training in the region.	To provide a valued choice to school leavers and working adults to acquire values, knowledge and skills for lifelong learning and enhanced employability. To provide valued supports to industries	

Company	Vision	Mission	Others
		for their manpower development.	
Wong Tung & Partners Limited	not found	not found	We are committed to quality, leadership and excellence in the service we provide.
Woods Bagot Ltd	not found	not found	We explore data to predict changing human behaviour.
WSP	not found	not found	5 thoughts: - Integrating More Nature in Cities - Reshaping the Urban Environment to Promote Health -Strengthening Community Engagement to Bring More Projects to Life -Rethinking Urban Planning in a Post-COVID World --Enabling Cities and Communities to Build a Resilient and Sustainable Future
Yau Lee Construction Company Limited	not found	not found	The Group upholds an innovative and flexible operation, as well as a momentum of continuous improvement, in order to enhance the working efficiency and competitiveness, providing even more professional services and high quality products to the customers. The Group also strives to seek other feasible business opportunities, so

Company	Vision	Mission	Others
			as to enlarge its business scope.
Young's Engineering Company Limited	Better Life, Better Home, Better Quality to You Everyday	We offer superior service, we create an integrated, convenient and safe living environment. We are devoted to serve: Customers - We provide customized service and maintain long term partnership. Staff - We promote work-life balance and create a strong sense of belonging. Community - We maintain sustainable development and contribute to community.	

Appendix 8 - Part (2) : Initial segments established from the statements

Abstract of Initial Segments Established

Object substance 1 **OS01**	Change on OS 1 **OC01**	Object substance 2 **OS02**	Change on OS 2 **OC02**	Object substance 3 **OS03**	Change on OS 3 **OC03**	Object substance 4 **OS04**	Change on OS 4 **OC04**
Client's complex challenges	resolved	communities	resiled	environment	resiled	nations	secured
Cities' needs requirements	served	Communities' needs	served				
professional institute status	strengthened	Innovation	fostered	Safety standard	uphold	security standard	uphold
design processes	smoothed	construction processes	smoothed	client's requirements	achieved		
new building high effectiveness	ensured	existing building high effectiveness	ensured	Best practices	promoted		
new technology	embraced						
technical excellence	promoted						
quality of project delivery	ensured						
best practice processes	optimised						
Client's challenges	resolved	Safety and sustainability	ensured				
quality of life	improved	Employees number	increased	Shareholders' value	increased		
research education	excelled	Student's talent	developed	social advancement	realised	economic advancement	realised
environmental impact	minimised	shareholders' value	maximised	employees' value	maximised	community's value	maximised
Construction industry sustainability	strengthened	Awareness of health and safety	increased	skills development	improved		
quality of services provided	ensured						
professionalism	enriched	construction industry performance standard	enhanced				
Client's satisfaction	achieved	employee's satisfaction	achieved	shareholders' satisfaction	achieved		
cost effectiveness of services	achieved	staff mind set for change	enhanced	relationship with worldwide	strengthened	work environment	enhanced
Safety	enhanced	quality of life	enhanced	environment-friendly	achieved		

Object substance 1 **OS01**	Change on OS 1 **OC01**	Object substance 2 **OS02**	Change on OS 2 **OC02**	Object substance 3 **OS03**	Change on OS 3 **OC03**	Object substance 4 **OS04**	Change on OS 4 **OC04**
client benefits	achieved	surveyors' benefit	achieved				
sustainability	achieved						
Client's benefits	achieved						
Safe living environment	created	sustainability of developments	achieved	employee work-life balance	promoted	employee's belonging	promoted
high quality of work	achieved	environmental sustainability	achieved				
Sustainability	achieved	Employee's job satisfaction	achieved	quality of products	achieved	quality of services	achieved
Sustainability	achieved	Shareholders' value	increased				
living environment	bettered	Clients' expectation	exceeded	Employee's career	ensured	Employee's development opportunity	ensured
Customers' needs	achieved	Rational use of public resources	ensured	Competency	maintained		
Workflow automation	achieved	Process automation	achieved				
Construction industry	improved						
Client's needs	achieved						
Client's needs	achieved	adequate pricing of tenders	enabled	client's interest	protected		
Value-added services to clients	achieved.						
Clients' requirements	achieved						
corporate social responsibility	committed						
sustainable returns for shareholders	generated	Safe environment for employees	provided	Career prospects of employees	provided		
Pioneering in the engineering profession	achieved						
Clients' needs	achieved	Local culture needs	achieved				
Change	driven	opportunity	created				

Object substance 1 **OS01**	Change on OS 1 **OC01**	Object substance 2 **OS02**	Change on OS 2 **OC02**	Object substance 3 **OS03**	Change on OS 3 **OC03**	Object substance 4 **OS04**	Change on OS 4 **OC04**
technical efficiency of projects	achieved	operational efficiency of projects	achieved				
Caring service	provided	Corporate citizen reputation	strengthened	Hong Kong core business	enhanced		
Society	bettered	Shareholders' long-term value	committed	Contemporary living culture	pioneered	customers' needs	achieved
high quality service	delivered						
customer satisfaction	pursued	social contribution	pursed				
Decision making	enhanced						
Client's objective	achieved						
Leadership of the organisation	achieved						
Sustainability	achieved						
Architectural design of buildings	improved						
Long term investment	maximized	Sharing of technology	achieved	Industry progression	driven		
forefront of industry	achieved	shareholders' value	enhanced	customers' values	enhanced		
Tenants' expectation	exceeded	Best-in-class services	achieved				
innovation design solutions	provided						
knowledge	advanced	economic development	assisted	social development	assisted		
bounds of scholarship	advanced	professional excellence	committed				
housing supply-demand imbalance problem	resolved						
Leader in education	achieved	valued supports to industries	provided				
high quality services	provided	leadership	achieved				
prediction of changing human behaviour	enabled						
community	strengthened	resilient future	enabled	sustainable future	achieved		

Object substance 1 **OS01**	Change on OS 1 **OC01**	Object substance 2 **OS02**	Change on OS 2 **OC02**	Object substance 3 **OS03**	Change on OS 3 **OC03**	Object substance 4 **OS04**	Change on OS 4 **OC04**
continuous improvement	upheld	working efficiency	enhanced	working competitiveness	enhanced	high quality products	provided
safe living environment	offered	work-life balance	promoted	sustainable development	maintained		

Appendix 8 - Part (3) : Results of the Final Round Listing

Change on OS 1	Object substance 1	Change on OS 2	Object substance 2	Change on OS 3	Object substance 3	Change on OS 4	Object substance 4
OC01	**OS01**	**OC02**	**OS02**	**OC03**	**OS03**	**OC04**	**OS04**
increase	Clients' satisfaction	resile	communities	resile	environment	secure	nations
served	Cities' needs requirements	served	Communities' needs				
strengthened	professional institute status	fostered	Innovation	uphold	Safety standard	uphold	security standard
smoothed	design processes	smoothed	construction processes	achieved	client's requirements		
ensured	new building high effectiveness	ensured	existing building high effectiveness	promoted	Best practices		
embraced	new technology						
promoted	technical excellence						
ensured	quality of project delivery						
optimised	best practice processes						
resolved	Client's challenges	ensured	Safety and sustainability				
improved	quality of life	increased	Employees number	increased	Shareholders' value		
excelled	research education	developed	Student's talent	realised	social advancement	realised	economic advancement
minimised	environmental impact	maximised	shareholders' value	maximised	employees' value	maximised	community's value
strengthened	Construction industry sustainability	increased	Awareness of health and safety	improved	skills development		
ensured	quality of services provided						
enriched	professionalism	enhanced	construction industry performance standard				
achieved	Client's satisfaction	achieved	employee's satisfaction	achieved	shareholders' satisfaction		
achieved	cost effectiveness of services	enhanced	staff mind set for change	strengthened	relationship with worldwide	enhanced	work environment
enhanced	Safety	enhanced	quality of life	achieved	environment-friendly		
achieved	client benefits	achieved	surveyors' benefit				
achieved	sustainability						
achieved	Client's benefits						

Change on OS 1	Object substance 1	Change on OS 2	Object substance 2	Change on OS 3	Object substance 3	Change on OS 4	Object substance 4
OC01	**OS01**	**OC02**	**OS02**	**OC03**	**OS03**	**OC04**	**OS04**
created	Safe living environment	achieved	sustainability of developments	promoted	employee work-life balance	promoted	employee's belonging
achieved	high quality of work	achieved	environmental sustainability				
achieved	Sustainability	achieved	Employee's job satisfaction	achieved	quality of products	achieved	quality of services
achieved	Sustainability	increased	Shareholders' value				
bettered	living environment	exceeded	Clients' expectation	ensured	Employee's career	ensured	Employee's development opportunity
achieved	Customers' needs	ensured	Rational use of public resources	maintained	Competency		
achieved	Workflow automation	achieved	Process automation				
improved	Construction industry						
achieved	Client's needs						
achieved	Client's needs	enabled	adequate pricing of tenders	protected	client's interest		
achieved.	Value-added services to clients						
achieved	Clients' requirements						
committed	corporate social responsibility						
generated	sustainable returns for shareholders	provided	Safe environment for employees	provided	Career prospects of employees		
achieved	Pioneering in the engineering profession						
achieved	Clients' needs	achieved	Local culture needs				
driven	Change	created	opportunity				
achieved	technical efficiency of projects	achieved	operational efficiency of projects				
provided	Caring service	strengthened	Corporate citizen reputation	enhanced	Hong Kong core business		

Change on OS 1	Object substance 1	Change on OS 2	Object substance 2	Change on OS 3	Object substance 3	Change on OS 4	Object substance 4
OC01	**OS01**	**OC02**	**OS02**	**OC03**	**OS03**	**OC04**	**OS04**
bettered	Society	committed	Shareholders' long-term value	pioneered	Contemporary living culture	achieved	customers' needs
delivered	high quality service						
pursued	customer satisfaction	pursed	social contribution				
enhanced	Decision making						
achieved	Client's objective						
achieved	Leadership of the organisation						
achieved	Sustainability						
improved	Architectural design of buildings						
maximized	Long term investment	achieved	continuous improvement	driven	Industry progression		
achieved	forefront of industry	enhanced	shareholders' value	enhanced	customers' values		
exceeded	Tenants' expectation	achieved	Best-in-class services				
provided	innovation design solutions						
advanced	knowledge	assisted	economic development	assisted	social development		
advanced	bounds of scholarship	committed	professional excellence				
resolved	housing supply-demand imbalance problem						
achieved	Leader in education	provided	valued supports to industries				
provided	high quality services	achieved	leadership				
enabled	prediction of changing human behaviour						
strengthened	community	enabled	resilient future	achieved	sustainable future		
upheld	continuous improvement	enhanced	working efficiency	enhanced	working competitiveness	provided	high quality products
offered	safe living environment	promoted	work-life balance	maintained	sustainable development		

Appendix 9: Master copy of Participant Information Sheet (PIS) and Consent Form

Master copy of Participant Information Sheet (PIS) sent to interviewees:

MIDDLESEX UNIVERSITY

Participant Information Sheet (PIS)
Date: 16 July 2021

Participant Identification Number: **XXnnn**

SECTION 1

1. Study title
The title of the study is "Change Management Framework for Effective BIM Implementations in Construction Industry."

2. The Invitation
You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Please take time to decide whether or not you wish to take part.

Thank you for reading this.

3. Purpose of the study

The purpose of the study is to facilitate the construction industry to achieve improvements by effective implementation of BIM to achieve more effective and efficient processes. The aims to be achieved are as follows:

- to enable stakeholders, practitioners and all concerned to comprehend the key features, capabilities, maturity etc. necessary for achieving the BIM benefits, and the factors such as cultural and organisational development factors etc. that need to be managed for BIM implementations
- to establish effective change management framework for use by individual organizations, by individual disciplines, and by individuals for BIM implementations at different phases of the asset life cycles.
- to facilitate establishment of roadmap appropriate for being considered by the industry for future implementations

4. Why you are invited
It is important that we assess as many participants as possible, and you have indicated that you are interested in taking part in this study. As a practitioner in the construction field, your comment and advice on the findings or contributions to the case study would be significant and valuable bases for consideration and incorporation in the change management framework. Besides you, there would be around 10 participants, with similar background with yours, will be involved in the study for interview or case studies.

5. Freedom to take part or not to

It is completely free for you to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. If you do decide to withdraw from the study then please inform the researcher as soon as possible, and they will facilitate your withdrawal.

If, for any reason (without the need to inform the researcher), you wish to withdraw your data please contact the researcher within a month of your participation. After this, it may not be possible to withdraw your individual data, as the results may have already been published. However, as all data is anonymised, your individual material will not be identifiable in any way.

6. Methods used in the study and Scope of your participation

Methods used in the study

Firstly, I would carry out the secondary research covering literature reviews, coupled with the presentations by BIM motivating organisations, stakeholders and practitioners in the construction industry presented in the former seminar, conference and forums; and published circulars, guidelines, policy addresses, etc. The findings would then be reviewed, analyzed and summarized in a proposed change management framework. Commentary and conclusions of the reviews would be prepared so as to justify the objectives and the needs.

The primary searches would then be conducted as follows:

Process 1: Further review of the findings from the secondary search by a larger group of subjects to obtain feedbacks, followed with analysis to reveal the validity and properties of the findings.

Process 2: Case studies based on the application of the proposed change management framework for further review or enhancement of the framework. After the case studies, more factors in the nature of influencers and restrainers regarding the change explored would be incorporate in the framework to be recommended for use by the construction industry.

Scope of your participation

You are invited to participate in Processes 1 to join an interview session to advise your comments/ advice to the concluded findings from the secondary search and results from the questionnaire completed. Should you kindly agree to join, I would follow up to arrange with you for the details of the interview accordingly.

Please note that in order to ensure quality assurance and equity this project may be selected for audit by a designated member of the committee. This means that the designated member can request to see signed consent forms. However, if this is the case your signed consent form will only be accessed by the designated auditor or member of the audit team.

7. Provision of any bodily samples (i.e. blood/saliva/urine)
Please be assured that not any such provision would be required for this research.

8. Possible disadvantages and risks of taking part
Please be informed that there is not any know or expected disadvantage or risk in participating in this project.

Appropriate risk assessments for all procedures have been conducted, and will be followed throughout the duration of the study.

9. Possible benefits of taking part
We hope that participating in the study will help you. However, this cannot be guaranteed. The information we get from this study may help us to aware of the factors that need to be considered and managed

9. Confidentiality of your taking part in this study
The research team has put a number of procedures in place to protect the confidentiality of participants. You will be allocated a Participant Identification Number that will always be used to identify any data you provide. Your name or other personal details will not be associated with your data, for example, the consent form that you sign will be kept separate from your data. All paper records will be stored in a locked filing cabinet, accessible only to the research team, and all electronic data will be stored on a password protected computer. All information you provide will be treated in accordance with the Data Protection Act in Hong Kong and UK.

10. What will happen to the results of the research study?
The results of the research study will be used as part of a Doctorate dissertation. The results may also be presented at conferences or in journal articles. However, the data will only be used by members of the research team and at no point will your personal information or data be revealed.

11. Who has reviewed the study?
The study has received full ethical clearance from the Research ethics committee who reviewed the study. The committee is the Transdisciplinary DProf Research Ethics Committee (REC).

12. Contact for further information

Please also refer to Section 2 for more details about the Middlesex University Privacy Notice for Research Participants.

If you require further information, have any questions or would like to withdraw your data then please contact us as follows:

My details:
Name: Low, Hon Wah
University email address: hl492@live.mdx.ac.uk

My supervisor's details:
Name: Dr Elda Nikolou-Walker,
Post: Senior Lecturer, Professional Practice

Address:
Department of Education
Middlesex University
Faculty of Professional and Social Sciences
The Burroughs
London NW4 4BT

Email address: E.Nikolou-Walker@mdx.ac.uk

Thank you for taking part in this study. Please ensure to keep this participant information sheet in a confidential manner as it contains your participant identification number, important information and the research teams contact details

SECTION 2

Middlesex University Privacy Notice for Research Participants

The General Data Protection Regulation (GDPR) protects the rights of individuals by setting out certain rules as to what organisation can and cannot do with information about people. A key element to this is the principle to process individuals' data lawfully and fairly. This means we need to provide information on how we process personal data.

The University takes its obligation under the GDPR very seriously and will always ensure personal data is collected, handled, stored and shared in a secure manner. The University's Data Protection Policy can be accessed here: https://www.mdx.ac.uk/__data/assets/pdf_file/0023/471326/Data-Protection-Policy-GPS4-v2.4.pdf.

The following statements will outline what personal data we collect, how we use it and who we share it with. It will also provide guidance on your individual rights and how to make a complaint to the Information Commissioner's Officer (ICO), the regulator for data protection in the UK.

Why are we collecting your personal data?

As a university we undertake research as part of our function and in our capacity as a teaching and research institution to advance education and learning. The specific purpose for data collection on this occasion is to use them as basis for analysis and reveal if there are any correlation amongst the survey answers and the characteristics of the subjects such as age, sex and/or working experience.

The legal basis for processing your personal data under GDPR on this occasion is Article 6(1a) consent of the data subject.

Transferring data outside Europe

In the majority of instances your data will be processed by Middlesex University researchers only or in collaboration with researchers at other UK or European institutions so will stay inside the EU and be protected by the requirements of the GDPR.

In any instances in which your data might be used as part of a collaboration with researchers based outside the EU all the necessary safeguards that are required under the GDPR for transferring data outside of the EU will be put in place. You will be informed if this is relevant for the specific study you are a participant of.

Your rights under data protection

Under the GDPR and the DPA you have the following rights:

- to obtain access to, and copies of, the personal data that we hold about you;
- to require that we cease processing your personal data if the processing is causing you damage or distress;
- to require us to correct the personal data we hold about you if it is incorrect;
- to require us to erase your personal data;
- to require us to restrict our data processing activities;
- to receive from us the personal data we hold about you which you have provided to us, in a reasonable format specified by you, including for the purpose of you transmitting that personal data to another data controller;
- to object, on grounds relating to your particular situation, to any of our particular processing activities where you feel this has a disproportionate impact on your rights.

Where Personal Information is processed as part of a research project, the extent to which these rights apply varies under the GDPR and the DPA. In particular, your rights to access, change, or move your information may be limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we may not be able to remove the information that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible. The Participant Information Sheet will detail up to what point in the study data can be withdrawn.

If you submit a data protection rights request to the University, you will be informed of the decision within one month. If it is considered necessary to refuse to comply with any of your data protection rights, you also have the right to complain about our decision to the UK supervisory authority for data protection, the Information Commissioner's Office.

None of the above precludes your right to withdraw consent from participating in the research study at any time.

Collecting and using personal data

Data sharing

Your information will be used only by the researcher only conducting the project you are participating in, mainly so that he can identify you as a participant and contact you about the research project.

Responsible members of the University may also be given access to personal data used in a research project for monitoring purposes and/or to carry out an audit of the study to ensure that the research is complying with applicable regulations. Individuals from regulatory authorities (people who check that we are carrying out the study correctly) may require access to your records. All of these people have a duty to keep your information, as a research participant, strictly confidential.

For this project, the researcher is not working with other organisations and information about you would not be shared.

Storage and security

The University takes a robust approach to protecting the information it holds with dedicated storage areas for research data with controlled access.

Alongside these technical measures there are comprehensive and effective policies and processes in place to ensure that users and administrators of University information are aware of their obligations and responsibilities for the data they have access to. By default, people are only granted access to the information they require to perform their duties. Training is provided to new staff joining the University and existing staff have training and expert advice available if needed.

Retention

Under the GDPR and DPA personal data collected for research purposes can be kept indefinitely, providing there is no impact to you outside the parameters of the study you have consented to take part in.

Having stated the above, the length of time for which we keep your data will depend on a number of factors including the importance of the data, the funding requirements, the nature of the study, and the requirements of the publisher. Details will be given in the information sheet for each project.

Contact us

Researcher details (name and University email address would be inserted

Supervisors' details (name, address, work number and email address) would be inserted

The University's official contact details are:

Data Protection Officer
Middlesex University
The Burroughs
London
NW4 4BT
Tel: +44 (0)20 8411 5555
Email: dpaofficer@mdx.ac.uk

Master copy of Consent Form

Participant Identification Number: XXnnn

CONSENT FORM

Title of Project: Change Management Framework for Effective BIM Implementations in Construction Industry.

Name of Researcher: LOW, Hon Wah

Please initial box

1. I confirm that I have read and understand the information sheet dated **16 July 2021** . for the above study and have had the opportunity to ask questions. [1]
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without penalty . [2]
3. I agree that this form that bears my name and signature may be seen by a designated auditor. [3]
4. I agree that my non-identifiable research data may be stored in National Archives and be used anonymously by others for future research. I am assured that the confidentiality of my data will be upheld through the removal of any personal identifiers. [4]
5. I understand that my interview may be taped and subsequently transcribed. [5]
6. I agree to take part in the above study. [6]

Name of participant	Date	Signature
LOW, HON WAH	2021	
Researcher	Date	Signature

☐ 1 copy for participant
☐ 1 copy for researcher

Appendix 10 : List of Coded and Collated Transcripts

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
Community - External	Government policy		A	4
	Government policy on mandatory BIM usage		A	1
	developments for smart cities		B	1
	requirement for carbon footprint reduction		B	1
	mandatory adoption of BIM			3
	mandatory use of BIM for Government capital projects		A	1
	BIM is mandatory requirement for all Government projects		A	1
	using BIM is a must		A	1
	not resources for adopting BIM, if not mandatory		A	1
	the need to change practices which have been established for a long time		A	1
	for projects without specific need for BIM adoption, can only suggest to adopt but could not enforce so		B	1
	holistic direction and plan for the change		A	1
	the "must" for changing in future		A	1
	positive side: industrialisation automation, AI etc are forcing the industry to change		A	1
	The demand of BIM usage in Government projects resulting in supply		A	1
	Government shall commit to invest for more BIM applications		A	1
	The industry is developing a new profession for BIM. This is not the good approach as		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	individual professionals shall use BIM by themselves.			
	Government shall exercise more push, such as establish major parameters for building submissions		A	1
	organise competition awards etc		A	1
	Government's push and market competition - would need to use BIM eventually after time		A	1
	personally feel positive as the market is becoming mature		B	1
	Government policy is one of the major factors		A	1
	no BIM union for practitioners to share practical applications, useful tools and sensors etc		A	1
	shall attract more young people to join the industry		B	1
	Government initiative in mandating the BIM adoption		A	1
	requirement for sustainability		B	1
	Government mandatory policy drive very strongly		A	1
	if not mandatory, people may have "no reason" to go ahead in using BIM		A	1
	education institutes start teaching BIM		A	1
	CIC certification of manager and coordinators have created demand for qualified personnel thus attracting young people to join		A	1
	bigger marker leads to bigger demand		B	1
	for design institutes in Mainland China, all have set up BIM team		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
Community - External Total				37
Community - Local	other factor: technology adopted by the construction sector		A	1
	market demand increased		A	1
	Developers, stake holders' recognition of the BIM benefits		A	1
	Demand from the industry		A	1
	contractual requirement		B	1
	due to the stringent requirement on cost and quality control		A	1
	the demand from the industry		A	1
	the shortage of staff		A	1
	The large amount of expenditure involved for the project works.		A	1
	increased number of projects requiring the use of BIM		A	1
	mandatory adoption of BIM			1
	increased demand for BIM		A	1
	change in market condition		A	1
	future trend in adoption		A	1
	demand for better sharing and exchange of information for coordination of works		B	1
	the need to use advance but not traditional technology		B	1
	BIM is not fully understood by other practitioners		B	1
	BIM model is not usable by all parties		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	e.g., the cladding design model cannot go to the manufacturing machine directly		A	1
	client side: better informed about the benefit		A	1
	Client considers that there is no added value		A	1
	Client do not know the value		A	1
	Client's unaggressive behaviour		A	1
	tenders specified with BIM consultancy, i.e. from CAD to BIM model as requirement		A	1
	If it could be proved that payment processes would be faster, then probably more contractors would use BIM>		A	1
	Tender specification requirements shall cover training courses for how to actually use the BIM model by each of the parties.		B	1
	also contractual requirement		A	1
	contractual requirement		B	1
	the office involves a number of non-capital works, for which BIM adoption is not mandatory		A	1
Community - Local Total				30
Environment - Individual discipline	sensed the need to train future engineers with BIM		A	1
	Way to implement: choose people with interest in BIM and with self-motivation, e.g., those who finance themselves for attending the courses		B	1
	for public authorities, much rely on precedent procedures, therefore not easy to change for adoption of new initiatives		B	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	instead of using architectural drawings, can now retrieve the geometry quickly		B	1
	additional fee for the projects		A	1
	adverse effect on works flow of the traditional management system		A	1
	shall conduct briefing on why and how BIM shall be used		A	1
	time issue: tight program of works - cannot with for the perfect model		A	1
	the different focus / views of different parties, e.g., engineer and surveyors		A	1
	contractors consider that the traditional 2D drawings are more reliable and therefore would stick to them		A	1
	the return is not justified when compared with the additional output		B	1
	positive: change in building regulations for submissions		A	1
	better way to present drawings than traditional submission		A	1
	nowadays the clients just request for BIM model but without using them in the FM stage		A	1
	analyse assets management system to explore BIM benefits in air quality control, access control etc		A	1
	models created by the designer are not benefited much in asset management, they are contributing much but not rewarded		A	1
	more promising future career prospect		B	1
	examples: software capability in structural analysis, wind effect		B	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	ability to enhance design both in geometry shapes and loading		B	1
	suitable data could be retrieved easier and quickly		B	1
	if new buildings are provided with BIM models reflecting actual as built environment - would help in FM		A	1
	there is around 20 to 30% of the expenditure involved in maintenance, daily repairs and minor alteration works - but difficult to find BIM ready people to serve the works		A	1
Environment - Individual discipline Total				22
Environment - Individual organisation	Top management decision		A	2
	own vision aligns with the company one		B	1
	to make these colleagues feel comfortable in making the change		B	1
	foresee the trend		A	1
	sense that will be lagging behind if not pursuing		A	1
	project team has reservation in using BIM		A	1
	headquarters' drive		A	1
	the difference in skill/capability level - affecting the overall performance		A	1
	not suitable for small fitting out projects		A	1
	not much opportunity to adopt BIM as the nature of works involved are property management related		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	culture of company is rather traditional		A	1
	anticipated benefits		A	1
	Threats of being lagged behind other		A	1
	makes works easier to complete		A	1
	as one of the many departments, need to facilitate other partners for them to join implementation		A	1
	as a start, use BIM internally within the department with a small project for trial running		A	1
	management sector recognised the importance of BIM		A	1
	maintaining competing edge		A	1
	no free time to learn/use due to heavy workload caused by massive volume of documents being handled		A	1
	not having the appropriate situation for adoption		B	1
Environment - Individual organisation Total				21
Environment - Non-technological	webinars offered by CIC		A	1
	hight cost of training		A	1
	inadequate supply of capable persons		A	1
	still not clear about how to make use of the information, how to make changes to the model when required, who is responsible for making the change?		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	e.g. typist is responsible to type document but shall not be asked to write the paper		A	1
	need to train up ourselves to use the alternatives		A	1
	promotion of BIM usage by non-profit organisation such as HKIBIM etc		B	1
	inadequate time		B	1
	the cost for building the model		A	1
	cannot realise the benefit after paying the model cost		A	1
	long payback period		A	1
	the anticipated long term financial benefit		A	1
	current training however does not achieve the objective		A	1
	High cost of personnel		A	1
	frequent change of jobs due to high demands in the market		A	1
	Positive: certification and award		B	1
	hurdle: academic teaching only, without adequate depth and coverage in practical use		B	1
	current courses on BIM concentrate on how to use BIM but not much on the use for architectural or structural design		B	1
	Some BIM trainers are non-construction professionals who might not be able to create BIM for use in the industry		B	1
	shall further develop BIM usage in facilities maintenance during the occupancy stage		A	1
	lack of accurate information on benefits that could be achieved		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	large amount of personnel that need to be trained/changed: there are around 120,000 practitioners, even 25% of them would be a large number		A	1
	need prioritisation - cannot do all at one time		B	1
	more introduction to students in practical ways		A	1
Environment - Non technological Total				24
Environment - Personal	Survival means, as BIM adoption is a must in future		B	1
	observation of the increasing importance		B	1
	have the challenge		B	1
	want to reduce amendments		B	1
	to have the design more easily presented		B	1
	If working in a small firm without such large expenditure, might not think in the same way, i.e. may not have the drive for implementation.		B	1
	some people would be conservative and not easy to change		B	1
	show cases to middle level colleagues and set as their precedent cases		B	1
	consider BIM is useful for FM		B	1
	foresee the need for the change		B	1
	realise the need for better sharing of information		B	1
	exploring the use opportunities		B	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	realised the need for future improvements		B	1
	conference, training etc provided by professional organisations		B	1
	eagerness in trying to use new technology		B	1
	ensure that they have the heart to do so		A	1
	People who don't know how to use BIM		A	1
	or those who could not see or make use of the BIM benefit		A	1
	no hands-on experience		B	1
	no time to learn in depth how to actually implement the BIM works		B	1
	provision of training to staff, in particular those for tasks handling		A	1
	provide adequate training and guidance		A	1
	adoption of real BIM would take time and change of people		A	1
	cannot be the pioneer as there are risk in investment		B	1
	not everyone has the correct concept on how BIM is applied		A	1
	need to know BIM is not only geometry information but data/ families of components		A	1
	eagerness to change		B	1
Environment - Personal Total				27
Environment - Technological	however, have challenges due to bugs in the systems		B	1
	Lack of standard library		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	lack of accurate information on what is BIM		A	1
	lack of accurate information on how should BIM be implemented		A	1
	lack of accurate information on the resources requirements		A	1
	technology keep on changing		A	1
	high cost of hardware and software		A	1
	some of these supports even come from outside Hong Kong and might not be good enough for use locally		A	1
	information not readily usable by other colleagues		A	1
	although sometimes quite discouraging due to software monopoly		A	1
	currently the software cost is high		A	1
	there should be alternatives for using		A	1
	must start to use first, like changing to use AutoCAD instead of tracing board in the past		A	1
	inadequate IT specialist skill		A	1
	do not have BIM models readily for use in the property management sector		A	1
	Negative: rapid changing technology, not easy to catch up		A	1
	negative: lack of skilled BIM resources		A	1
	bad choice of software		A	1
	positive: advancement in technology changes		A	1
	IT professional look at operations, steps and procedures rather that technical contents		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	Technical problems therefore still have to leave to technical people but not IT professional		A	1
	shall establish practical LOD, excessive one would lead to extra effort but not necessary		A	1
	too many software		B	1
	software too big		B	1
	too much changes/ developments in software		B	1
	technical supports sometimes not adequate		B	1
	positive: new interface opened to developers, facilitating applications		B	1
	use BIM to create digital twin		A	1
	The advocated "One model approach" lead to the question of ownership of the model and the changes.		A	1
	need to streamline the procedures etc so that it could be adopted throughout the life time		A	1
	restrainer: too technical for being learned or used		B	1
	inadequacy of software or hardware capability		A	1
	advancement of technology such as spatial definition for patrolling, defects checking etc would help to drive BIM adoption in FM		B	1
	Technology decoupling would be required for handling Common Data Environment (CDE) such as data conversion, management, maintenance etc.		A	1
Environment - Technological Total				34

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
Mission and Vision - Organisation	Top management takes the lead		A	1
	the vision in improving the construction industry		B	1
	alliance to business plan		A	1
	I am therefore the driver, establish a team to support the change in using BIM for FM		A	1
	not in line with the organisation mission		A	1
	decision made without the right mindset would adversely affect the adoption pace		A	1
	that is with internal (self) motivation		A	1
	alliance to investment plan		A	1
Mission and Vision - Organisation Total				8
Requirements by Client and/or others	Client's adoption of BIM usage		A	1
	contractual requirement		A	1
	the need to comply with the requirements in the BIM demands		A	1
	some clients begin asking for the provision of models		A	1
	positive: demands from other departments for BIM applications in their courses		B	1
	contractors and consultants have to change due to the demand from the market		A	1
	seems now the contractors are asked to do these but this shall not be the way		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
Requirements by Client and/or others Total				7
Resources availability - External	not much, as no additional resources have been granted		A	1
	project requirement - permit budget allowance for BIM		A	1
	CITF fund does not support academic institutions		A	1
	documents, guidelines issued by CIC		(blank)	1
	Free licence software for students' use		A	1
	cost: no additional fee for alterations and additions works as overall staffing hours not increased		A	1
	funding: from marketing expenditure as free pilot project		A	1
	Government subsidies in BIM adoption		A	1
	negative: if no additional payment for BIM adoption is available - will cause reluctance to use		A	1
	establish guidance on how to use BIM for better asset management		A	1
	User guide on how shall the standards be used shall also be established.		A	1
	Client's willingness to pay for the fee for BIM services		A	1
	e.g. BIM library - after setting up, it could only run one particular software, so the keenness in promoting is lessen		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	need to facilitate other software brand, e.g. accept for submissions		A	1
	CIC supports a lot in personal developments		B	1
	Positive: CIC continuous support		B	1
	The standards need to be practical, easy to be understood and performed.		A	1
	Shall establish standards meeting the base line requirements. Too high the standard would not be desirable as they would not be complied by most of the people.		A	1
Resources availability - External Total				18
Resources availability - Internal	allocation of resources for training staff, purchasing hardware and software		A	1
	availability of development funding		A	1
	Lack of financial resources for software, hardware		A	1
	Lack of application resources enabling self-learning		A	1
	Longer time required for creation of BIM models		A	1
	for Small and Medium Enterprises (SMEs) even with subsides for buying software may still consider it too costly		A	1
	supports from organisation are very important		B	1
	Hardware replacements follow normal route but not matching with the pace of requirements		A	1
	provision of supports for the changes		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	advocate quality assurance		A	1
	time used in the early stage can be chased back in the later stage: time not much increased		A	1
	additional resources available		B	1
	limited resources		A	1
	the resources required for training, in terms of time and money		A	1
	as a service provider, there is no incentive for implementing		A	1
	no assigned budget for implementing		A	1
	Cost		A	1
	In line with the vision, resources are available for additional space, training programme etc		A	1
	as cost of works have direct impact on profit		A	1
Resources availability - Internal Total				19
Road map - Organisational	future vision - smart or high tech for the project works with BIM as the founding platform		A	1
	promotion by give free services in demonstrative projects		B	1
	BIM is a language - you cannot work on it by your own even you are very good at it		A	1
	will provide free value-added services with BIM platform - to pursue clients to adopt and use BIM, attract them to start using BIM in small projects first		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
Road map - Organisational Total				4
Road map - Personal	more channels to inform the industry about BIM		B	1
	promotion to high school students		B	1
Road map - Personal Total				2
Self-motivation - Personal	self interest		B	1
	self-motivation		B	4
	more meaningful works		B	1
	Self-motivation		B	5
	most are self-motivation		B	1
	have never thought about stopping		A	1
	none, since my mindset is positive		B	1
	Own motivation		B	1
	not much effects as I have been taking the lead before the mandatory		A	1
	not much affected by the mandate since the changes take part before that		A	1
	driver: personally I want to improve		B	1
	want to do things better and better		B	1
Self-motivation - Personal Total				19

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
Sourcing strategy - In-house	establish a team to drive and monitor performance and progress		A	1
	provide suitable training		A	1
	If you don't know how to do BIM, don't just outsource it to others.		B	1
Sourcing Strategy - In-house Total				3
Sourcing Strategy - Outsource	contractors then request supports from others, such as BIM consultants and modellers		A	1
	the current trend of BIM specialist mode is not healthy - BIM shall be used by individual professional parties by their own but not outsourced to BIM specialist		B	1
	as a consequence of outsourcing BIM, would create a specialist profession or BIM firm. This is not healthy.		B	1
	have therefore leave to people with IT capability - i.e. outsource		B	1
	contractors consider it not justified to invest on this aspect and therefore tender to outsource the BIM works to others		A	1
Sourcing Strategy - Outsource Total				5
Target - Individual disciplines	better communication		B	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	construction processes could be improved with the use of advanced technology		B	1
	positive: the achievements in performing an engineer's responsibility		B	1
	contractually BIM shall start from design stage but not from construction		B	1
Target - Individual disciplines Total				4
Target - Individual organisation	reputations after using BIM		A	1
	save management resources		A	1
	increase efficiency		A	1
	maintain competing edge		A	1
	corporate direction		A	1
	corporate strategy		A	1
	in view of the trend in BIM adoption, will drop behind if it is not used		A	1
	formulation of the plan and objective		A	1
	examples are reduction in abortive works		A	1
	reduction in cost of works		A	1
	improvement on works quality		A	1
	minimise redo works		A	1
	enhancement of space arrangements		A	1
	increase efficiency of works		A	1
	direction given by the company management		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	decision to go ahead		A	1
	management of staff expectation		A	1
	the need to go ahead for using BIM		A	1
	coaching staff to realise the benefit for project delivery		A	1
	positive: the benefits of efficiency and quality improvement		A	1
	approach adopted for promotion: install BIM FM platform model for key clients		A	1
	use such as sample to demonstrate to the client, enable them to understand the portal, realise/ enjoy the benefit		A	1
	not only applicable in engineering or construction field, but diversify into other industry such as optometry and health care		A	1
	efficiency		A	1
Target - Individual organisation Total				24
Target - Personal	exploring of new technology		B	1
	aiming at improving work efficiency		B	1
	I do not want to repeat fault work or to solve problem repeatedly		B	1
	would like to advance the use of IT in the construction industry, which has been dropping behind when compared with other industries		B	1
	wish to facilitate submissions		B	1
	as leader: want to use advance technology		B	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	mission in delivering the best professional services - need to look for new/ better/ advance way and BIM is considered as one of them		B	1
	mission in delivering the best professional services		B	1
	want to have eye catching presentation		B	1
	helping the industry in improvements		B	1
	meaningful works		B	1
	promotion to higher position		B	1
	prioritising of works		B	1
Target - Personal Total				13
Willingness to change - Individual	willing to try		B	1
	the people's mind set issue		A	1
	human's behaviours for not willing to change		A	1
	culture and mind set - not eager to learn, use traditional mode		A	1
	shareholders reluctance in adopting BIM for projects that do not specifically request for BIM adoption		B	1
	refusal in adoption causing frustrations		B	1
	people issue - workers on site do not follow BIM model but still rely on traditional method		A	1
	better mind set of people		B	1
	negative: the difficulty to change mind-set		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	some staff have attended the courses but don't want to change to use new technology		A	1
	they don't like innovation or advanced technology		A	1
	if the team leader is not keen for the implementation, will not work		A	1
	someone may change if they foresee the good opportunity within a reasonable time		A	1
	people issue is the main thing as most of them might still have negative mind set and not changing		A	1
	working level: more introduction of BIM knowledge		A	1
	management system: people would resist to those that would affecting them		A	1
	change mind-set		A	1
	cultural change		A	1
	not any more, change mind set of all people, existing or new staff, is still most important		A	1
	own mind-set		B	1
	designers use BIM for presentation only but reluctant to use BIM for actual design drawings, tender details etc but still stick to traditional 2D drawings		A	1
Willingness to change - Individual Total				21
Willingness to change - Organisational	reluctance to change		A	1

Theme Codes	The Interview Responses		Cat.	Theme Codes counts
	reduce reluctance in adoption		A	1
	those at director level need to change traditional mind-set		A	1
	For private projects that without the mandatory requirement, more reluctance for adoption would exist.		A	1
	reluctance in changing		A	1
Willingness to change - Organisational Total				5
Grand Total				347

Appendix 11 : Master copy of Interview Guide

Middlesex University London

Interview Guide

Participant Identification Number:	

Interview Particulars

Date:		
Time:		
Media/ Venue		

1 Preliminary Questions and Briefing

1.1 Thank you for participating in the interview for the research project. May I have your consent in recording this interview meeting?
[If the answer is negative, turn off the recording device and inform the interviewee that recording would not be made but notes of the meeting would still be taken.]

(For Chinese native Interviewee go to question 1.2, for others go to question 1.3)

(For interview with audio recording only: read out "This is an audio record of the interview held on [date] with [name] whose Participant Identification Number is [PIN].)

1.2 Thank you for joining this interview and agreeing to have the meeting recorded. While the interview questions are presented in English, to facilitate discussions, you might use Chinese with English terms to give your advice. After that I would prepare the notes in English only for your comments. May I know if this is acceptable to you please?

1.3 Thank you for joining this interview and agreeing to have the meeting recorded. The interview questions and discussions would be conducted in English. After that I would prepare the notes in English for your comments. May I know if this is acceptable to you please?

Please be informed you Participant Identification Number as shown in the Participant Information Sheet would be used as source identification in the project works without your name or other related information.

[Discuss with interviewee to ensure that s/he is clear about and understand the contents in the Participant Information Sheet such as the purpose of study, freedom to take part or not to, methods of study, scope of the interviewee's participation, and the contacts for further information.]

2 The Interview Questions

2.1 May I know about your overall major role in the organisation you are working with/ institution you are representing?

2.2 May I know what are the objectives and plan of your organisation / institution in BIM usage?

2.3 May I know your role or assigned responsibility in BIM adoption?

User category:

As stated in the BIM Adoption Survey 2019 issued by the Hong Kong Construction Industry Council, users are be categorised BIM Leaders, BIM Adopters and BIM Laggers. In line with the report contents, each of these categories might be defined as follows:

- BIM Leaders: users that on average use BIM in more than 80% of their projects / works
- BIM Adopters: those who have used BIM but not so extensive as BIM Leaders
- BIM Laggers: those who has not heard of BIM or does not have active BIM projects

2.4 A. Which of the above category would you select to best describe your organisation in terms of BIM adoption?

B. Which of it would best describe yourself?

Questions 2.5 to 2.25 would be asked based on answer given in 2.4A for the organisation first. After that the same set of questions would be asked again based on the answer given in 2.4B for the interviewee.

(For BIM leaders and Adopters go to question 2.5, for BIM Laggers go to question 2.12)

2.5 (For BIM Adopters only) What would be the approximate average percentage of the projects/ works using BIM?

2.6 In the past, what have been the major factors that have driven/ helped your organisation/ you to change to adopt BIM?

2.7 In what ways these factors have helped in implementing the changes?

2.8 Comparatively, what are the factor(s) that have the most driving/helping force for making the change?

2.9 Why do you consider so?

2.10 Conversely what have been the factors that have stopped you from the change implementation?

2.11 Eventually how have them been overcome?
(End of question to BIM Leader and Adopters, Go to question 2.18)

(Questions for BIM Laggers.)

2.12 In the past, what have be the major factors that have stopped your organisation / you to change to adopt BIM?

2.13 In what ways these factors have stopped in implementing the changes?

2.14 Comparatively, what are the factor(s) have the most restraining force for not making the change?

2.15 Why do you consider so?

2.16 Conversely what have been the factors that might have driven/ helped you to implement the change?

2.17 Why eventually they are not successful?
(End of questions to BIM Laggers. Go to question 2.18)

2.18 In future, what are your anticipated factors that that would either have positive or negative effects on the BIM adoption processes?

2.19 How would they affect the adoption processes?

2.20 How should these factors be managed to achieve better results?
(if non-technological factors have been covered in the above, go to question 2.23)

2.21 Besides the technological issues, what are the non-technological factors that need to be considered and handled in managing the changes imposed by the BIM implementations?

2.22 How have they affected the BIM adoption?

(End of questions on non-technological factors. Go to question 2.23)

2.23 For the above mentioned factors, what do you think are the effects imposed by the Hong Kong Government's mandate on the use of BIM for her projects?

2.24 How have these factors been affected?

2.25 How could the effects from the mandate be managed in order to maximise their strength in driving/ helping implementation of the change in BIM adoption?

[After completion of the above based on answer given for question 2.4A (for user category of the organisation), go back to question 2.5 to 2.25 based on the answer given in 2.4B (for user category of the interviewee.]

(After completion of the above for both A and B: End of Interview Questions)

2.26 Thank you for the kind advice given. I have finished asking the interview questions, may I know if you have any other advice or supplements that you want to add please?

Thank you again for joining this interview. This is the end of the interview.

(End of Interview)

Appendix 12 : Full set of Change Management Framework (version 0.1)

Part A: Worksheet on Summary

Change Management Framework (ver 0.1)

1 User and Framework Application Particulars

Please insert the following particulars:

User Name /Nick name:

User's Major Responsibilities:

Change Management for:

Framework application date:

2 Comparison with Previous Application Records

If an application of this framework has been done previously, and that comparison assessments are required, please ensure to have the data in the last application copied (in text mode) in area highlighted in blue below before proceeding with Step 3 below.

3 New/ Update Application

Please go to Worksheet "Data" to input the particulars for the application and then proceed with Step 4 onwards.

4 Summary of Computed Force Effects in this application

Please review the following and amend input data in Worksheet "Data" if necessary. If they are in order, please go to Step 5 at the right à.

as at *(Please inserted at 1 above)*	Net Force Effect				
	Current		Target		
	Net Force Effect	*relative ratio*	Net Force Effect	*relative weighting*	
Category 1 - Strategy	0.0	*0.00*	0.0	*0.00*	
Category 2 - Locality	0.0	*0.00*	0.0	*0.00*	
Category 3 - Affordability	0.0	*0.00*	0.0	*0.00*	
Category 4 - Manageability	0.0	*0.00*	0.0	*0.00*	
Category 5 - External Propensity	0.0	*0.00*	0.0	*0.00*	
Total Net Force	**0.0**		**0.0**		
Minimum Force Magnitude	*0.0*		*0.0*		

5 Influential Power Adjustment

Please insert below the estimated Influential Power adjustments to the Force effect. For those with a relatively stronger influential power, please insert a percentage larger than 100%, and vice versa. (i.e.100% stands for no adjustment is required).

Immemar Power Adjustments to Force Effects	
For Current	For Target
100%	100%
100%	100%
100%	100%
100%	100%
100%	100%
100%	100%

Adjusted Net Force Effect				
Current		Target		
Force Effect	*relative weighting*	Force Effect	relative weighting	
0.0	*0.00*	0.0	*0.00*	
0.0	*0.00*	0.0	*0.00*	
0.0	*0.00*	0.0	*0.00*	
0.0	*0.00*	0.0	*0.00*	
0.0	*0.00*	0.0	*0.00*	
0.0		**0.0**		
0.0		*0.0*		

Your major responsibilities; --

(**For reference only** - Relative Influence Power based on Researcher's survey			
Overall	Directorial	Managerial	Executional
175%	225%	288%	100%
197%	267%	250%	146%
100%	100%	100%	123%
219%	217%	263%	246%
261%	167%	500%	262%

It is highly recommended to have this Worksheet be saved NOW before further proceeding with the applications.

for printing - Change management framework 20220114.xlsxSummary

Page 1 of 2

Change Management Framework (ver 0.1)

5 Last Application Results (if any)

Please copy ALL the last application results (in text mode) in the appropriate cells below.

	as at *(date of last application)*									
	Net Force Effect				Influential Power Adjustments to Force Effects		Adjusted Net Force Effect			
	Current		Target				Current		Target	
	Net Force Effect	*relative ratio*	Net Force Effect	*relative ratio*	For Current	For Target	Force Effect	*relative ratio*	Force Effect	relative ratio
Category 1 - Strategy										
Category 2 - Locality										
Category 3 - Affordability										
Category 4 - Manageability										
Category 5 - External Propensity										
Total Net Force										
Minimum Force Magnitude										

6 Comparison Assessments with previous application

The comparisons will use the last application results as basis. For Driving Force Effects, a positive % change would indicate that the Force imposed are relatively higher than the one in the last assessment, and vice versa. In case if the base is a Restraining Force Effect(i.e. in a negative figure), then an computed negative % would indicate a reduction of the Restraining Force, i.e. the new Force is comparatively weaker than the last one.)

	Net Force Effect Comparisons				Difference in Influential Power Adjustments		Adjusted Force Effect Comparisons			
	Current		Target				Current		Target	
	Change in Net Force Effect		Net Force Effect		For Current	For Target	Change in Net Force Effect		Net Force Effect	
Category 1 - Strategy	0.0		0.0		0%	0%	0.0		0.0	
Category 2 - Locality	0.0		0.0		0%	0%	0.0		0.0	
Category 3 - Affordability	0.0		0.0		0%	0%	0.0		0.0	
Category 4 - Manageability	0.0		0.0		0%	0%	0.0		0.0	
Category 5 - External Propensity	0.0		0.0		0%	0%	0.0		0.0	
Overall total	**0.0**		**0.0**				**0.0**		**0.0**	
	0%	Addition in Driving Force	***0%***	Addition in Driving Force			***0%***	Addition in Driving Force	***0%***	Addition in Driving Force

It is highly recommended to have this Worksheet be saved before making amendment or further proceeding with the applications.

Appendix 12 : Full set of Change Management Framework

Part B: Worksheet on Data

Change Management Framework (ver 0.1)												
Application User:	--	Date of Application:	--									
					Current effects of the factors			Upon achievement of Target		Computed Net Force Effect		
					Achievement	Force Effect	Force value imposing on the change processes	Force Effect	Force Values	(+ve = driving; -ve= restraining)		
Major Change Factors	Sample Ultimate Target to be Achieved for the Change to adopt BIM implementation (for reference only) / Notes	Planned Targets to be achieved	Current Achievements		F= Fully; S= Substantially; P = Partially; N = None/ nearly none; NA = Not applicable	The force imposed on Change Implementation (D = Driving; R = Restraining)	0 =None/ not applicable; 1 = very weak; 2 = weak; 3 = strong; 4 = very strong; 5 = dominating	D or R	(0-5)	Current	Target	
Category 1- Strategy	This Category refers to the roadmap and intended movement for the changes to be implemented.											
Sourcing Strategy - total in source	All the changes would be implemented by in-house. *(Note: If the Strategy is to outsource **all** the works imposed by the changes, further application of this framework would **NOT** be necessary.*									--	--	
Sourcing Strategy - partially outsource	Only part of changes would be implemented by in-house. *(Note: If the Strategy is to outsource part of the works imposed by the changes, inputs to the following should confine to the works to be carried out by in-house only.)*									--	--	
Mission and Vision - organisation	Clear and well defined mission and visions covering the targeted changes has been established, published and conveyed to all parties									--	--	
Road map - organisational	Clear and well defined Organisational Road map for implementing the change has been established, with thorough discussions with all involved parties.									--	--	
Road map - personal	*For personal development only:* Road map for personal developments for implementing the change has been established									--	--	
Target - individual disciplines	Clear and well defined targets for implementing the changes in the appropriate discipline has been established.									--	--	
Target - individual organisation	Clear and well defined targets for implementing the changes for the organisation as a whole has been established, with thorough discussions with all appropriate stakeholders and executors									--	--	

Change Management Framework (ver 0.1)										
Application User:	--	**Date of Application:**	--	**Current effects of the factors**			**Upon achievement of Target**		**Computed Net Force Effect**	
				Achievement	**Force Effect**	**Force Value imposing on the change processes**	**Force Effect**	**Force Values**	**(+ve = driving; -ve= restraining)**	
Major Change Factors	**Sample Ultimate Target to be Achieved for the Change to adopt BIM implementation** ***(for reference only)*** **/ Notes**	**Planned Targets to be achieved**	**Current Achievements**	F= Fully; S= Substantially; P = Partially; N = None/ nearly none; NA = Not applicable	The force imposed on Change Implementation (D = Driving; R = Restraining)	0 =None/ not applicable; 1 = very weak; 2 = weak; 3 = strong; 4 = very strong; 5 = dominating	D or R	(0-5)	**Current**	**Target**
Target - personal	*For personal development only:* Clear and well defined targets for implementing the personal changes has been established								--	--
Additions factors by applicant, if any *(Please confine to 5 additional most significant factors only.)*										
									--	--
									--	--
									--	--
									--	--
									--	--
									--	--
						Total Net Force for Category 1- Strategy:			**0**	**0**

Change Management Framework (ver 0.1)										
Application User:	--	**Date of Application:**	--	**Current effects of the factors**			**Upon achievement of Target**		**Computed Net Force Effect**	
				Achievement	**Force Effect**	**Force Value imposing on the change processes**	**Force Effect**	**Force Values**	**(+ve = driving; -ve= restraining)**	
Major Change Factors	**Sample Ultimate Target to be Achieved for the Change to adopt BIM implementation** *(for reference only)* **/ Notes**	**Planned Targets to be achieved**	**Current Achievements**	F= Fully; S= Substantially; P = Partially; N = None/ nearly none; NA = Not applicable	The force imposed on Change Implementation (D = Driving; R = Restraining)	0 =None/ not applicable; 1 = very weak; 2 = weak; 3 = strong; 4 = very strong; 5 = dominating	D or R	(0-5)	**Current**	**Target**
Category 2 - Locality	**This Category is referring to the conditions of the personnel and organisation itself in terms of the readiness for implementing the change.**									
Willingness to change - individual	All the personnel involved have shown their willingness to change.								--	--
Willingness to change - organisational	All the parties, including Directional, Managerial and Executional, have reached consensus in implementing the change.								--	--
Environment - personal	All the personnel involved are well equipped / educated to implement the change.								--	--
Self-motivation - Personal	All the personnel involved are self-motivated strongly to implement the change.								--	--
									--	
									--	
									--	
									--	
Additions factors by applicant, if any *(Please confine to 5 additional most significant factors only.)*										
									--	--
									--	--
									--	--
									--	--
									--	--
						Total Net Force for Category 2 - Locality:			**0**	**0**

Change Management Framework (ver 0.1)										
Application User:	--	**Date of Application:**	--	**Current effects of the factors**			**Upon achievement of Target**		**Computed Net Force Effect**	
				Achievement	**Force Effect**	**Force Value imposing on the change processes**	**Force Effect**	**Force Values**	**(+ve = driving; -ve= restraining)**	
Major Change Factors	**Sample Ultimate Target to be Achieved for the Change to adopt BIM implementation** ***(for reference only)*** **/ Notes**	**Planned Targets to be achieved**	**Current Achievements**	F= Fully; S= Substantially; P = Partially; N = None/ nearly none; NA = Not applicable	The force imposed on Change Implementation (D = Driving; R = Restraining)	0 =None/ not applicable; 1 = very weak; 2 = weak; 3 = strong; 4 = very strong; 5 = dominating	D or R	(0-5)	**Current**	**Target**
Category 3 - Affordability	**Refers to the level of affordability in implementing the change or not to change**									
Resources availability - external	All available external resources have been applied for and obtained.								--	--
Resources availability - internal	Necessary internal resources, in addition to the external ones, are adequate to meet the change requirements.								--	--
									--	
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									--	
Additions factors by applicant, if any *(Please confine to 5 additional most significant factors only.)*										
									--	--
									--	--
									--	--
									--	--
									--	--
				Total Net Force for Category 3 - Affordability:					**0**	**0**

Change Management Framework (ver 0.1)										
Application User:	--	**Date of Application:**	--	**Current effects of the factors**			**Upon achievement of Target**		**Computed Net Force Effect**	
				Achievement	**Force Effect**	**Force Value imposing on the change processes**	**Force Effect**	**Force Values**	**(+ve = driving; -ve= restraining)**	
Major Change Factors	**Sample Ultimate Target to be Achieved for the Change to adopt BIM implementation** *(for reference only)* / **Notes**	**Planned Targets to be achieved**	**Current Achievements**	F= Fully; S= Substantially; P = Partially; N = None/ nearly none; NA = Not applicable	The force imposed on Change Implementation (D = Driving; R = Restraining)	0 =None/ not applicable; 1 = very weak; 2 = weak; 3 = strong; 4 = very strong; 5 = dominating	D or R	(0-5)	**Current**	**Target**
Category 4 - Manageability	**Refers to the factors that are mostly within the purview or under the controls by the individual person or the organisation**									
Community - Local	All the parties with working relationships are ready to adopt the change implementation.								--	--
Environment - Individual discipline	Consensus from all the practitioners within the same discipline for the change have been reached and they are all well equipped and ready for implementing the change.								--	--
Environment - individual organisation	All the parties within the organisation, including Directional, Managerial and Executional, are well equipped and ready to implement the change.								--	--
Requirements by Client and/or others	Sufficient communications with the Client and other contractual parties involved have been done and all of them are convinced or already in the good position to implement the change.								--	--
Additions factors by applicant, if any *(Please confine to 5 additional most significant factors only.)*										
									--	--
									--	--
									--	--
									--	--
									--	--
				Total Net Force for Category 4 - Manageability:					**0**	**0**

Change Management Framework (ver 0.1)										
Application User:	--	**Date of Application:**	--	**Current effects of the factors**			**Upon achievement of Target**		**Computed Net Force Effect**	
				Achievement	**Force Effect**	**Force Value imposing on the change processes**	**Force Effect**	**Force Values**	**(+ve = driving; -ve= restraining)**	
Major Change Factors	**Sample Ultimate Target to be Achieved for the Change to adopt BIM implementation** *(for reference only)* / **Notes**	**Planned Targets to be achieved**	**Current Achievements**	F= Fully; S= Substantially; P = Partially; N = None/ nearly none; NA = Not applicable	The force imposed on Change Implementation (D = Driving; R = Restraining)	0 =None/ not applicable; 1 = very weak; 2 = weak; 3 = strong; 4 = very strong; 5 = dominating	D or R	(0-5)	**Current**	**Target**
Category 5 - External Propensity	**Refers to the "external" factors that the person or organisation itself do not have much control but are having influences to the change implementations**									
Community - External	All the external parties, although without direct working or contractual relationship, are at the appropriate position to implement the change or to support the implementation.								--	--
Environment - non technological	All the non-technical issues hindering the change processes have been cleared.								--	--
Environment - technological	All he technical problems have been cleared and are in favouring position for making the change.								--	--
									--	
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									--	
Additions factors by applicant, if any *(Please confine to 5 additional most significant factors only.)*										
									--	--
									--	--
									--	--
									--	--
									--	--
				Total Net Force for Category 5 - External Propensity:					**0**	**0**
						OVERALL TOTAL:			**0**	**0**

Appendix 13: Case Inputs in the Data Worksheets by the case study participants

			Current Effect of the Factors			Upon Achieve-ment of Targets		Computed Net Force Effect	
Major Change Factors	**Planned Targets to be achieved**	**Current Achievements**	Achievement	Force Effect	Force Value imposing on the change processes	Force Effect (D or R)	Force Value (0-5)	Current	Target
Category 1- Strategy	-	-							
Sourcing Strategy - total in source	Partial in-house	Partial in-house	P	D	3	D	5	3	5
Sourcing Strategy - partially outsource	Partial in-house	Partial in-house	F	D	4	D	4	4	4
Mission and Vision - organisation	Clear and well defined mission and visions covering the targeted changes has been established, published and conveyed to all parties	Road map has been defined and shared with shareholders	P	D	2	D	4	2	4
Road map - organisational	Clear and well defined Organisational Road map for implementing the change has been established, with thorough discussions with all involved parties.		F	D	4	D	4	4	4

			Current Effect of the Factors			Upon Achieve-ment of Targets		Computed Net Force Effect	
Major Change Factors	**Planned Targets to be achieved**	**Current Achievements**	Achievement	Force Effect	Force Value imposing on the change processes	Force Effect (D or R)	Force Value (0-5)	Current	Target
Road map - personal	For personal development only: Road map for personal developments for implementing the change has been established							--	--
Target - individual disciplines	Clear and well defined targets for implementing the changes in the appropriate discipline has been established.		F	D	5	D	5	5	5
Target - individual organisation	Clear and well defined targets for implementing the changes for the organisation as a whole has been established, with thorough discussions with all appropriate stakeholders and executors		F	D	5	D	5	5	5
Target - personal								--	--

			Current Effect of the Factors			Upon Achieve-ment of Targets		Computed Net Force Effect	
Major Change Factors	**Planned Targets to be achieved**	**Current Achievements**	Achievement	Force Effect	Force Value imposing on the change processes	Force Effect (D or R)	Force Value (0-5)	Current	Target
Additions factors by applicant, if any *(Please confine to 5 additional most significant factors only.)*	-	-							
								--	--
Total Net Force for Category 1- Strategy:								**23**	**27**
Category 2 - Locality	-	-							
Willingness to change - individual	All directors should share the same vision and be actively involved in new projects acquisition adopting the roadmap	BIM division has been created and is running	P	D	2	D	5	2	5
Willingness to change - organisational	Directors should be trained for embracing the change		P	D	2	D	5	2	5
Environment - personal	Directors should be trained for embracing the change		P	D	2	D	4	2	4

			Current Effect of the Factors			Upon Achieve-ment of Targets		Computed Net Force Effect	
Major Change Factors	**Planned Targets to be achieved**	**Current Achievements**	Achievement	Force Effect	Force Value imposing on the change processes	Force Effect (D or R)	Force Value (0-5)	Current	Target
Self-motivation - Personal	All the personnel involved are self-motivated strongly to implement the change.		P	D	1	D	5	1	5
Additions factors by applicant, if any *(Please confine to 5 additional most significant factors only.)*	-	-							
								--	--
Total Net Force for Category 2 - Locality:								**7**	**19**
Category 3 - Affordability	**-**	**-**							
Resources availability - external	Ceiling to be increased	Fund adoption	S	D	4	D	5	4	5
Resources availability - internal	Resources to be increased	Small internal financial investment	P	D	2	D	5	2	5

			Current Effect of the Factors			Upon Achieve-ment of Targets		Computed Net Force Effect	
Major Change Factors	**Planned Targets to be achieved**	**Current Achievements**	Achievement	Force Effect	Force Value imposing on the change processes	Force Effect (D or R)	Force Value (0-5)	Current	Target
Additions factors by applicant, if any *(Please confine to 5 additional most significant factors only.)*	-	-							
Total Net Force for Category 3 - Affordability:								**6**	**10**
Category 4 - Manageability	**-**	**-**							
Community - Local			N	R	4	D	5	-4	5
Environment - Individual discipline	Consensus from all the practitioners within the same discipline for the change have been reached and they are all well-equipped and ready for implementing the change.		S	D	4	D	4	4	4

			Current Effect of the Factors			Upon Achieve-ment of Targets		Computed Net Force Effect	
Major Change Factors	**Planned Targets to be achieved**	**Current Achievements**	Achievement	Force Effect	Force Value imposing on the change processes	Force Effect (D or R)	Force Value (0-5)	Current	Target
Environment - individual organisation	All the parties within the organisation, including Directional, Managerial and Executional, are well equipped and ready to implement the change.		N	R	3	D	4	-3	4
Requirements by Client and/or others	Sufficient communications with the Client and other contractual parties involved have been done and all of them are convinced or already in the good position to implement the change.		P	D	1	D	5	1	5
<u>Additions factors by applicant, if any</u> *(Please confine to 5 additional most*	-	-							

			Current Effect of the Factors			Upon Achieve-ment of Targets		Computed Net Force Effect	
Major Change Factors	**Planned Targets to be achieved**	**Current Achievements**	Achievement	Force Effect	Force Value imposing on the change processes	Force Effect (D or R)	Force Value (0-5)	Current	Target
significant factors only.)									
Total Net Force for Category 4 - Manageability:								**-2**	**18**
<u>Category 5 - External Propensity</u>	**-**	**-**							
Community - External	All the external parties, although without direct working or contractual relationship, are at the appropriate position to implement the change or to support the implementation.		S	D	4	D	4	4	4
Environment - non technological	All the non-technical issues hindering the change processes have been cleared.		P	D	2	D	4	2	4

			Current Effect of the Factors			Upon Achieve-ment of Targets		Computed Net Force Effect	
Major Change Factors	**Planned Targets to be achieved**	**Current Achievements**	Achievement	Force Effect	Force Value imposing on the change processes	Force Effect (D or R)	Force Value (0-5)	Current	Target
Environment - technological	All the technical problems have been cleared and are in favouring position for making the change.		S	D	4	D	5	4	5
Additions factors by applicant, if any *(Please confine to 5 additional most significant factors only.)*	-	-							
Total Net Force for Category 5 - External Propensity:								**10**	**13**
OVERALL TOTAL:								**44**	**87**