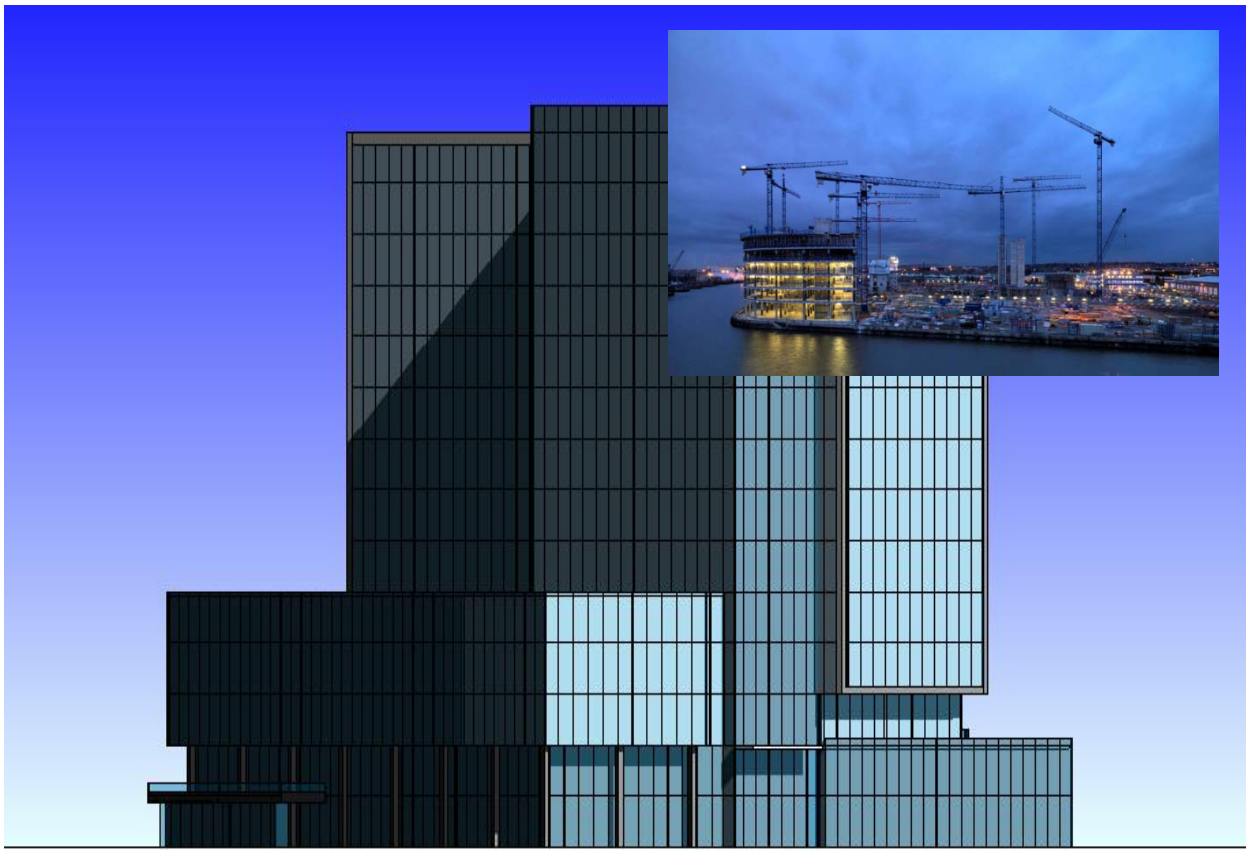
PROJECT AND FACILITIES MANAGEMENT USING BIM: UNIVERSITY OF SALFORD RELOCATION MANAGEMENT TO MEDIA CITY



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Executive Summary

MediaCityUK is a regeneration project expected to attract media institutions locally and from around the world thus establishing itself as an international centre for excellence. A study has been carried out by the University of Salford to appraise the MediaCityUK project on the extent to which it is expected to contribute to the sustainable cities vision put forward by the UK government. Also there is a planned relocation by some departments of the University of Salford to the allocated building in the MediaCityUK development. This move highlights the need for a well managed cost effective and sustainable relocation process. As part of the above study, this report focuses on the benefits of BIM (Building Information Model) in the project management and consequent facilities management of the planned move.

The report addresses the relocation process management under two major heading which reflects the two parts involved which are; project management of the relocation process and facilities management during the occupancy period. The study focused on digital modelling, relocation efficiency and performance benchmarking during life cycle to identify BIM benefits.

The BIM tool selected for this study is the Revit Architecture software by Autodesk. There were constraints in quality of data retrieval hence a “what if” scenario which attempts to replicate the accurate data capture was adopted for this study.

BIM model contribution to time planning during the relocation was analysed by comparing with generated MediaCityUK model using the identified items from first objective. This satisfied the second study objective.

Second objective comparisons revealed the contributions of BIM in FM maintenance operations and space management thus fulfilling third and fourth study objectives.

1.0 Introduction

The MediaCityUK is a £500m development which is purpose built for media and creative. It is owned and managed by Peel Media; Phase 1 of MediaCityUK (due for completion in 2011) covers more than 36 acres, with the potential to develop up to 200 acres in the future (Peel group 2009).

The BBC will move around 2,500 staff to MediaCityUK and the University of Salford will also have a presence at MediaCityUK, a brand new campus for more than 800 students and staff (Urban Vision & Salford City Council joint report, 2009). The planned move of the media related department of the University of Salford will require relocation of light and heavy equipments to designated spaces within the MediaCity development. Such planned move is expected to incur cost from a PM (Relocation project/process management) point of view. Without proper scheduling of the planned move and time planning, the entire project stands the risk of cost overrun and delayed completion (Lewis 2007), which altogether will result to huge financial losses. For maximum benefits to be derived from the MediaCityUK building during its life cycle there is the need to optimise the building from an FM point of view. Industry research suggests that 85% of the lifecycle cost of a facility occurs after construction is completed and the NIST (National Institute of Standards and Technology) Interoperability Study indicated that fully two-thirds of the estimated $15.8 billion lost are due to inadequate interoperability occurs during operations and maintenance phases (Jordani 2010, Rundell 2006). The maintenance requirement of the building (Hard issues) such as cleaning of window doors etc will require a managed approach due to the size of the facility. It is also important to identify designed and actual occupant functions (Soft issues) and allocate spaces during the building life cycle for operational efficiency. Space reallocation is a consideration that shouldn’t be overlooked as the functional requirement of owner/user might change with time which also underscores building life cycle management.

BIM can be considered an ambiguous term (Aranda-Mena et al 2008). However, its application as an integrated design method has brought significant advances to design and delivery of new construction projects (Attar et al 2010). By adopting BIM, architects, engineers, contractor’s operators and owners can easily create

coordinated digital design information and documentation (Boutwell 2008); and use that information to more accurately visualize, simulate and analyze performance, appearance (Lenard 2010).

Adopting the BIM technique will also enable interoperability amongst industry professionals as the Industry Foundation Classes (IFC) creates the desired platform for Facility Managers to share digital datasets (Gillard et al 2008). The importance of BIM tool with interoperable platform and dataset is reflected in the National Institute of Standards and Technology (NIST) study which quantified approximately $15.8 billion in annual costs of inadequate interoperability in the U.S. capital facilities industry in 2004 (NIST 2004).

1.1 Study overview

BIM is certainly changing the way buildings are designed and constructed (Rundell 2006), but is it changing how they're operated and maintained? Can it contribute to the relocation exercise of the University of Salford?

In this study, an attempt is being made to identify the benefits of BIM in the relocation exercise of University of Salford to MediaCityUK. The study methodology involves literature review and single case study of MediaCityUK. The literature review was used to identify key challenges of PM and key tasks of FM. Also under literature review, best practice for FM using BIM and BIM related guidance for FM were explored (See Figure 1.1). A hypothetical model was developed at this stage.

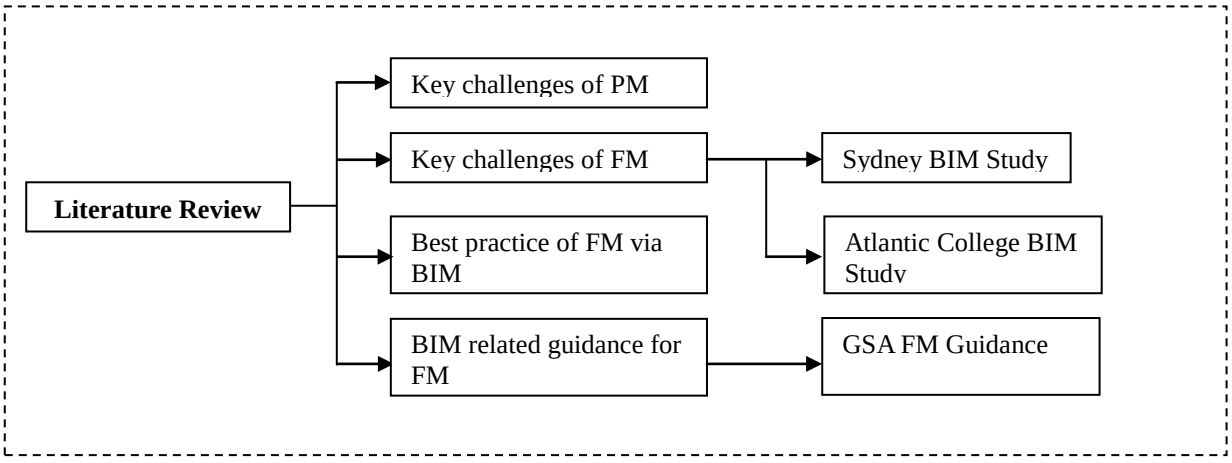


Figure 1.1 Literature Review Structure

The single case study which consists of literature reviews, interviews and BIM model Analysis was used to test the model (See Figure 1.2).

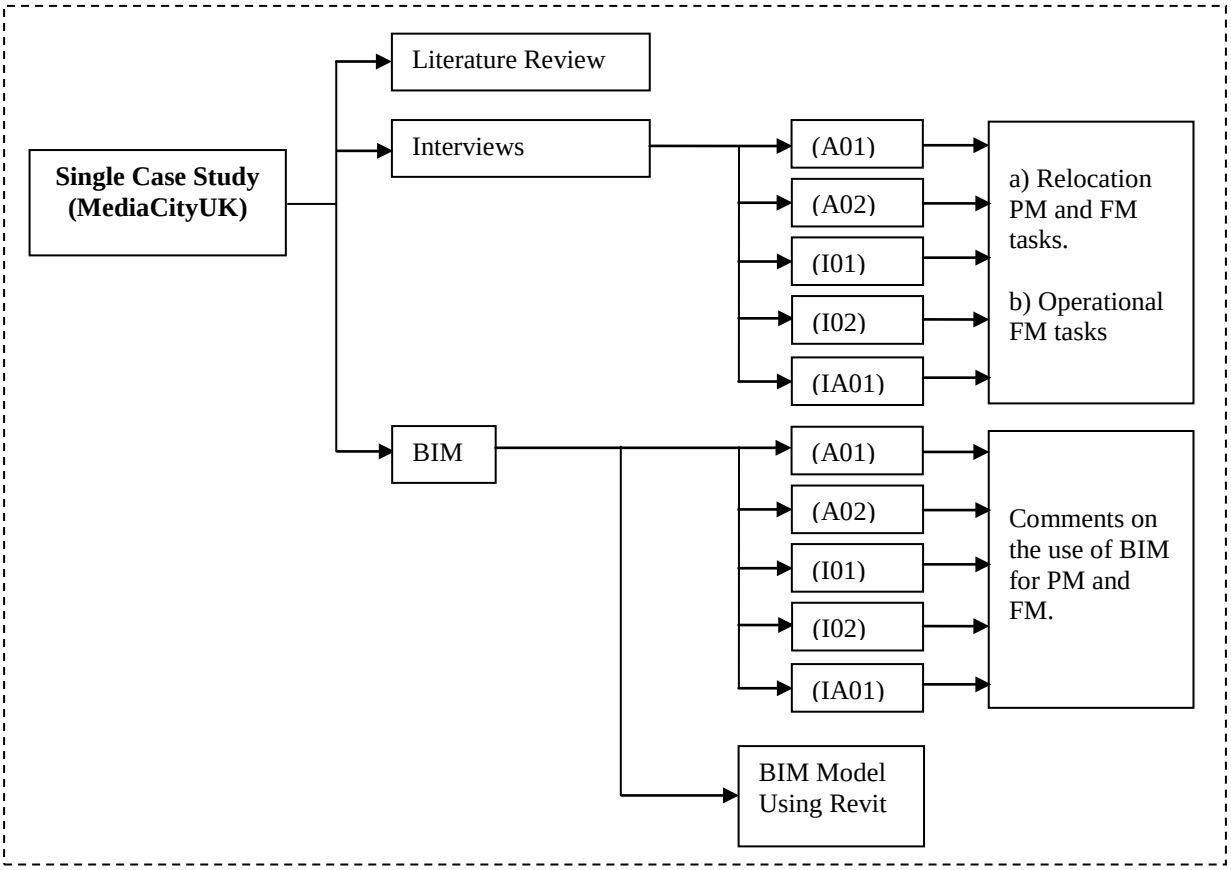


Figure 1.2 Single Case Study Structure for MediaCityUK

A BIM model of MediaCityUK is generated with information provided. The generated BIM model emphasis is on elements such as; the space topology and designated allocation, designed furniture layout, door and window openings, access routes within the building, design character and location of vertical transport facilities within the building such as lifts and stairs (Attar et al 2010).

The study's aim to identify the contribution of BIM to the relocation project/process management (*Scheduling, Time Planning*) and facilities management (*Building Maintenance, Building use Management*) (Autodesk 2007) to Salford University's MediaCity building. As a result four study objectives were generated this helped arrive at the study's conclusions.

1.1.1 Study Objectives

There are four study objectives:

i) To identify what items are required for scheduling the relocation of University of Salford to MediaCityUK using BIM.

ii) To identify how the BIM model can contribute to time planning during the relocation.

iii) To demonstrate how BIM contributes to maintenance operations of the MediaCityUK facility

iv) To demonstrate how BIM can contribute to the space management of the MediaCityUK facility.

1.1.2 Study Limitations/Assumptions

The limitations of the study were encountered primarily during the BIM model production stage and involved lack of access to adequate accurate input information to generate a minimal error high accuracy BIM model. This resulted in optimising available input information/data and executing a “what if” scenario which is expected to be closely similar to the actual MediaCity UK building. Considering the aim of the study which involves relocation project/process and facilities management, the critical information required to achieve the study objectives is to a degree present in the presentation drawings provided. Such information involve door and window approximate dimensions and positions, space object topology and function, entire layout of each floor provided (ground to third floor plans). It is also important to point out that without the section drawings it was rather difficult and time consuming but not impossible to articulate the double floor merger which involved voids in ground and first floor levels.

Some of the assumptions made during the generation of the MediaCityUK “what if” BIM model scenario from information provided were in the following areas:

i) Wall thicknesses, ii) Door types and door dimensions iii) Furniture types, as it was difficult to determine the material type from the 2D conceptual drawings obtained.

It is important to point out that the BIM model generated which is considered sufficient for this study as the minor approximations above are considered to have no significant effect on the validity of the study findings.

2.0 BIM in Relocation Process Project and Facility Management

In order to determine how BIM can support the planned relocation to MediaCityUK it is important the processes involved in the relocation is identified.

The two important processes will involve both project and facility management. Attributes of these two management processes are necessary both for the planned move and continued maintenance of the facility.

It is important however, to point out that while the project management of the planned move is limited to the relocation, the facility management is not only necessary for the relocation but is a lot more required throughout the entire lifecycle of the building see Figure 2.1.

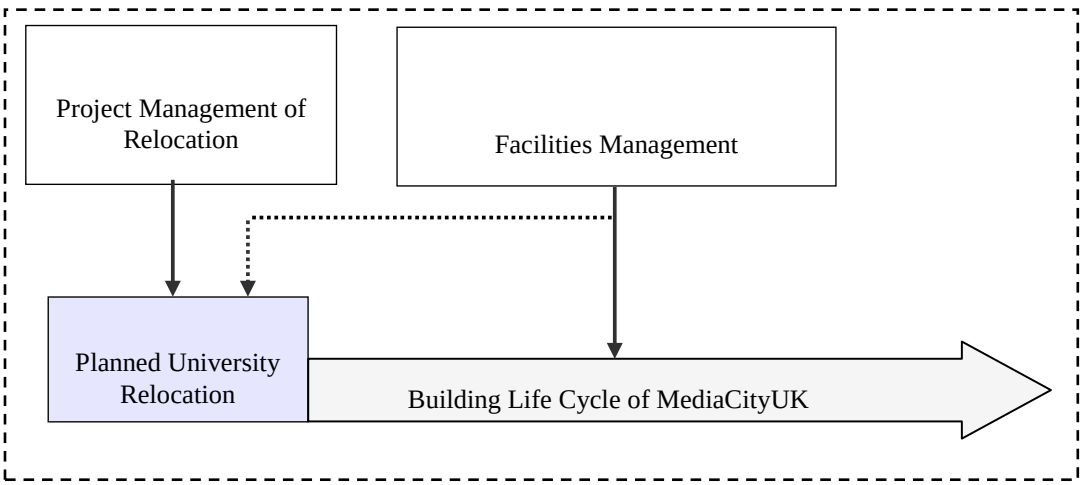


Figure 2.1 FM and Relocation PM to MediaCityUK BIM Application Model

2.1 Project management (PM):

Project management deals with the management of activities which meets the definition of project “has a beginning and an end” (Haughey 2008), irrespective of size or order of magnitude. It is also important to acknowledge that the end and the process for producing it cannot be fully specified in advance (Heerkens 2007). However, one of the common definitions which have been adopted in this paper is as follows:

Project Management is the art of directing and coordinating human and material resources throughout the life of a project by using modern management techniques to achieve predetermined objectives of scope, cost, time, quality, and participant satisfaction (PMI Standards Committee, 1987,p. 4-1 cited in Packendorff 1995). This definition agrees with that of (Lewis 2007) who simply puts it as application of skills tools and techniques to achieve project requirements.

Considering project management principle, Lewis (2007) describes the relationships between PCTS as:

$$C=f(P,T,S)$$

Where cost ‘C’ is a function of performance ‘P’, time ‘T’ and ‘S’ scope illustrated graphically as a triangle below:

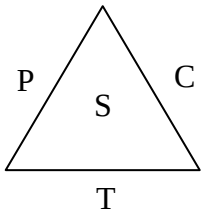


Figure 2.2 Lewis (2007) PCTS triangle;

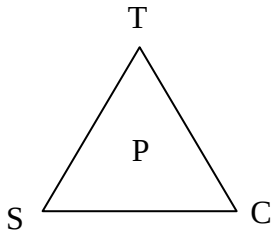


Figure 2.3 Haughey (2008) PCTS triangle

Lewis (2007) depiction in some strategic ways differs from the depiction of the same relationships by Haughey (2008) (See Figure 2.3). Unlike Lewis (2007) (See Figure

2.2), who put scope as the central variable illustrated by the area of the triangle, Haughey (2008) put forward the idea that customer expectations referred to as satisfactory quality/performance level, is the central theme hence its importance at the centre of the triangle. However, it can be said that the correctness or applicability of either of the triangle model (Figure 2.2 & 2.3) will depend on the nature of the individual project and client type.

The project management outlined in this paper is limited to the relocation process. However, the principles and approach remains similar to that applied in a much wider sense with differences on the levels of emphasis on each task. During the relocation project management there are key tasks and challenges which are involved. In order to accurately identify the contribution of BIM, these tasks and challenges have to be identified and explored. A work breakdown structure (WBS) (Lewis 2007) can help identify these tasks some of which are listed in section 2.1.1 below.

2.1.1 Key Challenges of Relocation PM

a) Establishing goals
b) Development and confirmation of budget
c) Preparation of responsibility matrix
d) Development of RFPs (request for proposals) for vendor participation
e) Determination of move logistics and critical path
f) Generation of furniture inventory database and preparation and confirmation of move matrix
g) Preparation of time plan
h) Review of construction documents for move issues such as correlation and documentation of actual/as-built specification and area of spaces involved
i) Preparation of move packet
j) Coordination of vendors
k) Implementation of service and technology bridging
l) Provision of on-site coordination and Supervision of all move related vendors
m) Follow-up of vendors
n) Addressing of surplus items

o) Ensuring compliance of relocation works with all regulatory requirements

The goal establishment is important in PM as this will reduce waste of time resource. According to Baker et al (2003), the time, resources results and customer satisfaction are interrelated. If you change one of these, you must then change the others to keep things in balance.

The common project management tasks include establishing objectives, breaking work into well defined task, preparation of responsibility matrix, charting the work sequences, scheduling, and budgeting development, coordinating a team, reporting and communicating throughout the project (Baker et al, 2003).

One of the common difficulties in running a project is that insufficient time is spent at the beginning of the job defining exactly what problem is to be solved and planning (Lewis 2000). One of the major problems that project managers face is an increased scope of the project as time passes (Lewis 2000). It is also important to point out that when the sponsor dictates across all four variables PCTS (See Figures 2.2 & 2.3), that is a recipe for failure as the Project manager should have one variable to adjust in order to meet sponsors demands (Lewis 2007).

2.2 Facilities Management (FM)

According to (RICS FM Assessment of Professional Competence p.5) Facilities management is the total management of all services that support the core business of an organisation which includes its building. However, today's buildings (such as the university building in MediaCityUK) are increasingly sophisticated and the need for information to operate and maintain them is vital (Jordani 2010). Within the context of this study, FM was designed to cover the relocation and post relocation processes. The management of the facility becomes necessary at the start of the relocation process and is expected to carry on through the life cycle of the facility even when the relocation project management is completed. The daunting challenges of FM are revealed when the information exchange challenges

experienced during design/construct is multiplied across the lifecycle of a facility (Jordani 2010).

Hinks (2003) cited in (Olomolaiye et al 2004) divided the forms of FM into two categories hard and soft issues. Hard issues have been linked to “management and maintenance of properties” while soft issues includes “management of support services”. Olomolaiye et al (2004) went on to point out that some issues can be classified either way such as cleaning (NHS 2003) cited in Olomolaiye et al (2004).

For the purpose of this paper, the classification approach of Olomolaiye et al (2004) was adopted where there was an attempt to divide FM considering the people and technological issues. People issues are placed under ‘soft FM category’ and technological issues under the ‘hard FM category’. However, the soft and hard issues can be referred to as FM tasks.

2.2.1 Key Tasks of Facilities Management (FM)

The various tasks in FM are numerous and in a lot of cases are organisation and building type specific. Some of the key tasks potentially relevant to the facility under consideration (MediaCityUK) are outlined below under soft and hard tasks.

The soft tasks include workspace utilization management such as:

a) Office Space Management: Audit of space utilization, space re-designs. Flexible working and on-going space utilization management.
b) Cleaning
c) Catering
d) Waste disposal and recycling (hazardous waste should be disposed according to all applicable laws [GSA 2008])
e) Reception
f) Security
g) IT/Switchboard

Some of the soft tasks have management element such as:

h) Calculating and comparing costs for required goods or services to achieve maximum value for money
i) Managing and leading change to ensure minimum disruption to core activities
j) Liaising with tenants of commercial properties
k) Coordinating and leading a team or teams of staff to cover various areas of responsibility
l) Using performance management techniques to monitor and demonstrate achievement of agreed service levels and to lead on improvement
m) Coordinating and leading a team or teams of staff to cover various areas of responsibility
n) Using performance management techniques to monitor and demonstrate achievement of agreed service levels and to lead on improvement
o) Responding appropriately to emergencies or urgent issues as they arise
p) Directing and planning essential central services such as reception, security, maintenance, mail, archiving, cleaning, catering, waste disposal and recycling

Hard task also include actual physical maintenance of the following which should be on-going (GSA 2008):

q) Normal power systems (Electrical substations) and Emergency power systems (Standby generators)
r) Building Automation System (BAS), security and locks
s) Sprinkler systems, Smoke/fire detection systems and Fire Extinguishers, Signage and Evacuation plans
t) Mechanical and Engineering (M&E engineering)
u) Windows and doors

Other hard tasks include:

v) Checking that agreed work by staff or contractors has been completed satisfactorily and following up on any deficiencies

2.3 Building Information Model

Freeman (2009) defines BIM as the natural progression of the use of computer aided design (CAD) tools to combine graphic objects with parametric dimensions in a way that simulates actual construction results even before groundbreaking. The progression has been from 2D to 3D, 4D, and BIM. While 3D models make valuable contributions to communications, not all 3D models qualify as BIM models since a 3D geometric representation is only part of the BIM concept (GSA 2010). Building Information Modelling (BIM) as an integrated digital description of a building and its site comprises of objects described by accurate 3D geometry, with attributes that define the detail description of the building part or element, and relationships to other objects (Mitchell and Schevers 2006). The virtual world potential adopting immersive technology of the BIM model creates opportunity for stakeholder immersive perception of the building (Okeil 2010). It is able to bring together the different threads of information used in construction into a single operating environment thus reducing, and often eliminating, the need for the many different types of paper documents (Froese 2008). It improves collaboration and aids faster question and answer turnaround time between project team members (Kymell 2008). BIM also can be used as an information framework for storing and retrieving FM related data (Freeman 2009). There are various interoperable object based BIM tools that could be used for this study such as ArchiCAD by Graphisoft, Industry Foundation Classes (IFC) by BuildingSmart, Revit by Autodesk. Revit by Autodesk was selected for two major reasons:

a) Purpose built for BIM: The Revit software is capable of organising the BIM model generation process and allows for attention to details. It has the capability for real-time material scheduling and a user friendly interface.

b) Availability: This is one of the important reasons for selection as the University of Salford holds a license to Revit hence accessible for use in this study which is a university project.

BIM have been employed in numerous projects and is still being used. In March 2008, the U.S. General Services Administration's (GSA) Public Buildings Service (PBS) signed an agreement with three international real estate organizations to support open standards for Building Information Modelling (BIM) software and systems. It has also mandated that every new facility and major modification project

should utilize a BIM model for spatial validation." (Boutwell 2008) cited in (Gillard et al 2008). This corroborates Froese (2008), that BIM is not a short lived trend.

2.4 Building Information Model Application in Sydney Opera House

One of the exemplars of the BIM adoption is its application in the Sydney Opera House (SOH) (See Figure 2.4) aimed at identifying best practice in the FM industry.

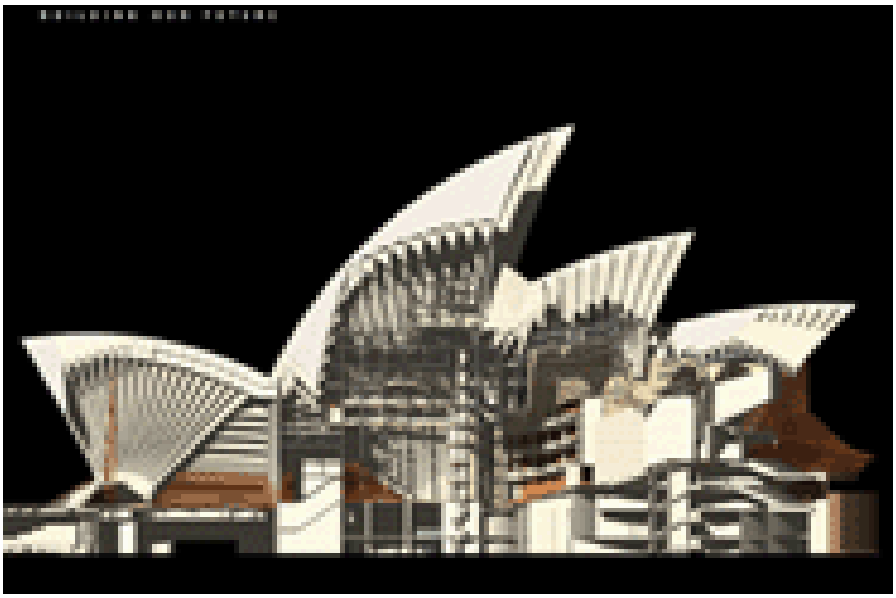


Figure 2.4 Sydney Opera House (SOH)
(Image from www.construction-innovation.info/)

Major FM related challenges and concerns were included a) the building complexity, b) insufficient independent systems to service the building, c) inadequately delivered up-to-date information of facility to business functions, d) the potential of strain on the capacity of existing facility services as a result of planned major building upgrades. However the BIM conversion was carried out without technical difficulties for reasons which include: a) good documentation policies by SOH, b) the nature of the IFC (industry foundation class) model specification requirement of the BIM protocol and its correspondence in nomenclature to the SOH data; hence interoperable, c) the opportunities for innovative processes provided by the BIM environment itself (Mitchell 2005). In conclusion the study successfully drafted SOH

current building standards for a BIM environment and the benefits can only be harnessed when BIM is adopted operationally by SOH.

According to Mitchell (2006), some of the benefits of BIM identified during the SOH study are:

The key benefit of BIM:

a) Its accurate geometrical representation of the parts of a building in an integrated data environment.

Related benefits:

b) Faster and more effective processes — information is more easily shared, can be value-added and reused
c) Better design — building proposals can be rigorously analysed, simulations can be performed quickly and performance benchmarked, enabling improved and innovative solutions
d) Controlled whole-life costs and environmental data — environmental performance is more predictable, life cycle costs are understood
e) Better production quality — documentation output is flexible and exploits automation
f) Automated assembly — digital product data can be exploited in downstream processes and manufacturing better customer service — proposals are understood through accurate visualisation life cycle data — requirements, design, construction and operational information can be used in FM

Also according to Gillard et al (2008), for the SOH project of BIM for FM benefits have been held to include:

a) Maximising “efficiencies and effectiveness in how SOH makes purchases, avoiding unnecessary purchases;
b) Ensuring that procurement decisions are made on the basis of whole-life costs, cultural fit and not solely short term financial criteria;
c) Ensuring that purchasing will be coordinated between departments where possible; in order to
d) Improve efficiency, appropriately planned and timed so as to increase overall value without increasing cost.”(Morris et al 2006)

The conclusion from the SOH exemplar of BIM application in FM is that it has proved highly successful, for a building that is both an icon and intended to have a design life of at least 250 years, requiring sensitive adjustment to cultural change and demand over time and sustainable maintenance of the fabric and fittings (Gillard et al 2008).

From the study, the BIM component led to significantly improved energy efficiencies and management of the Opera House. The BIM provided a single, consistent and up-to-date view of all aspects of the facility and this revolutionary approach will support future productivity growth in the FM industry (Gillard et al 2008).

2.5 The Atlantic College case study

This study attempted to illustrates how the use of BIM can be an essential tool for the design and maintenance of buildings, which are to be refurbished following a sustainable methodology. According to Gillard et al (2008), Gillard Associates adopted BIM generated 3D modeling approach when they began design of the refurbishment of 1960's student accommodation blocks at Atlantic College, Wales, in late 2007, seeking to create a project which enhances the natural environment. See Figure 2.5.

Figure 2.5 One of the three accommodation blocks at Atlantic College prior to renovation. Image from; (Gillard et al 2008).

One of the goals of BIM use in the Atlantic College Project was to eliminate the confusion error and delay on site hence the reduction of total build cost. An example of the cost savings according to Gillard et al (2008) cited in Autodesk (2004), is the BAA's anticipated savings of 10% of the building procurement cost from the use of BIM on Terminal Five informed by previous experience from the Heathrow Express project.

According to Gillard et al (2008) prior to the Atlantic College Project, apart from a few trail-blazing initiatives such as SOH study, little work has yet been accomplished in the use of BIM for managing and renovating existing buildings. However, the benchmark SOH projects do however indicate that the building information modelling of existing buildings which might be on the increase due to current sustainability requirements requires a significantly different approach to that taken on new projects. The models developed for new builds do not necessarily fit for renovation purposes (Penttilä et al 2007). It is essential to note, that in renovation projects the inventory model does not contain just geometrical data, but it has to be able to contain all the design project related information which is needed in the process, and by all project participants (Penttilä et al 2007).

The study conclusions laid much importance on interoperability of BIM software programmes; however some other important findings are as follows:

a) With the help of three-dimensional assessment of design solutions of a BIM model, there are improvements on the quality and the information exchange between the parties, reducing the number of design errors, increasing the efficiency of the design process and ensuring that the end result conforms to the objectives.
b) In addition to the investment costs and functionality, the life-cycle costs and environmental impact are usually also included in the assessment whenever possible, because their comparison using simulations is one of the principal benefits of integrated BIM.” However, there is held to be a current over-emphasis on the new-build aspects of BIM (design and procurement only) which needs correction to ensure that the model supports the FM data over the complete facility life cycle from

conception to demolition, extending current over-emphasis on design and construction phase (Senate 2007).

c) The use of BIM can provide such advantages that small practices can competitively achieve outcomes based on the successful use of BIM that show similar characteristics to those achieved in leading international renovation projects;

d) A lasting relationship can be forged between the consultant and the client in assisting in managing the model and then the building stock.

In the future it is probable that the most important Building Information Model is the one that is held in IFC format (Gillard et al 2008).

2.6 BIM Application Hypothetical Model for FM and PM

Findings from literature were used to develop a hypothetical model which shows the levels at which BIM could contribute to the different relocation/lifecycle FM and relocation PM tasks and the relationships between relocation/lifecycle FM and PM.

Table 2.1 and 2.2 illustrates the codes adopted for the hypothetical concept map.

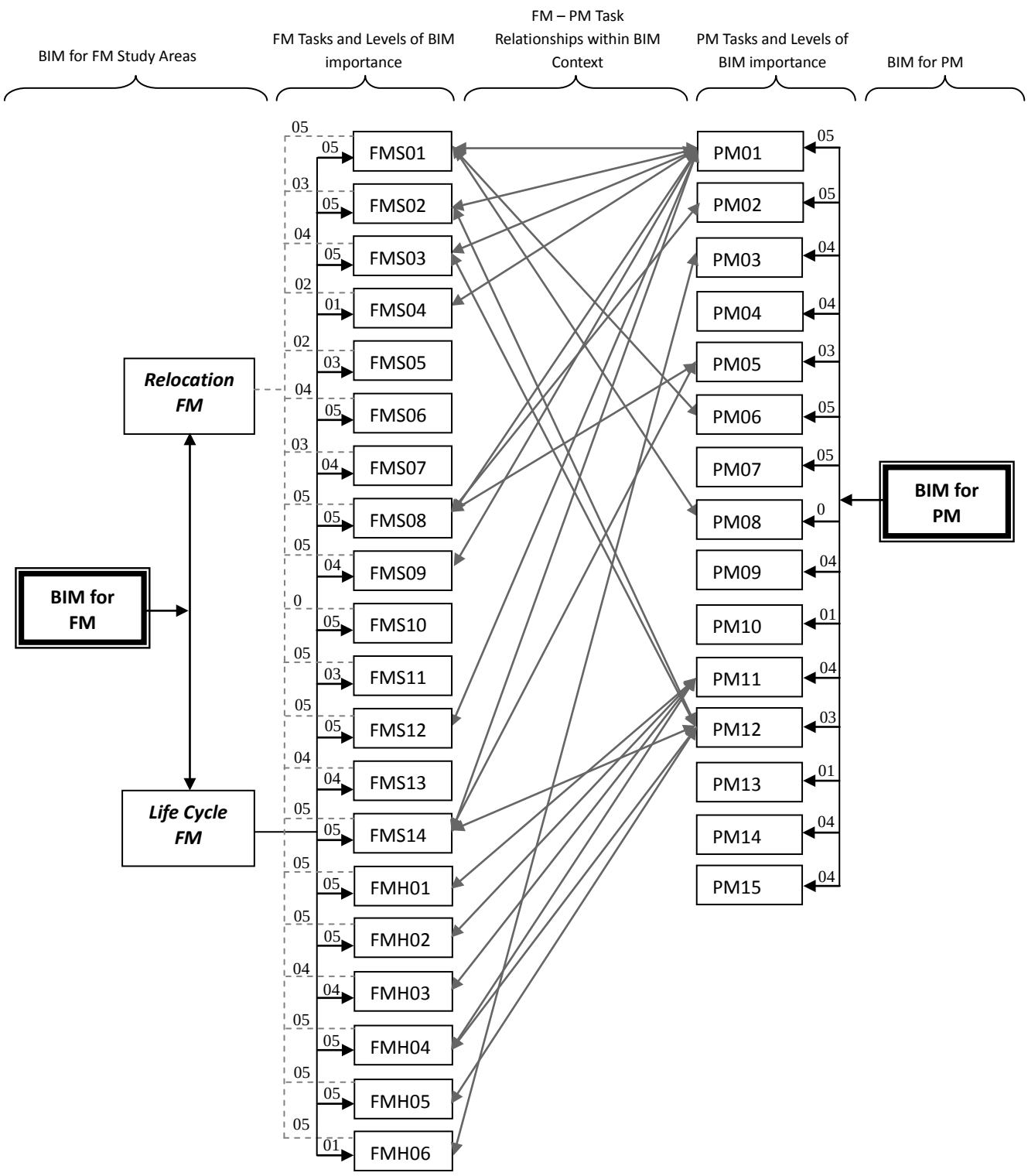
Table 2.1 Codes on FM tasks used in the hypothetical concept map/model

Codes	**FM Tasks**
FMS01	i) Office Space Management: Audit of space utilization, space re-designs. Flexible working and on-going space utilization management.
FMS02	ii) Cleaning
FMS03	iii) Catering
FMS04	iv) Waste disposal and recycling
FMS05	v) Reception
FMS06	vi) Security
FMS07	vii) IT/Switchboard
FMS08	viii) Calculating and comparing costs for required goods or services to achieve maximum value for money
FMS09	ix) Managing and leading change to ensure minimum disruption to core activities
FMS10	x) Liaising with tenants of commercial properties
FMS11	xi) Coordinating and leading a team or teams of staff to cover various areas of responsibility
FMS12	xii) Using performance management techniques to monitor and demonstrate achievement of agreed service levels and to lead on improvement
FMS13	xiii) Responding appropriately to emergencies or urgent issues as they arise
FMS14	xiv) Directing and planning essential central services such as reception, security, maintenance, mail, archiving, cleaning, catering, waste disposal and recycling
FMH01	xv) Normal power systems (Electrical substations) and Emergency power
FMH02	xvi) Building Automation System (BAS), security and locks
FMH03	xvii) Sprinkler systems, Smoke/fire detection systems and Fire Extinguishers, Signage and Evacuation plans
FMH04	xviii) Mechanical and Engineering (M&E engineering)
FMH05	xix) Windows and doors
FMH06	xx) Checking that agreed work by staff or contractors has been completed satisfactorily and following up on any deficiencies

Table 2.2 Codes on PM tasks used in the hypothetical concept map/model

Codes	**PM Tasks**
PM01	a) Establishing goals
PM02	b) Development and confirmation of budget
PM03	c) Preparation of responsibility matrix
PM04	d) Development of RFPs (request for proposals) for vendor participation
PM05	e) Determination of move logistics and critical pat
PM06	f) Generation of furniture inventory database and preparation and confirmation of move matrix
PM07	g) Preparation of time plan
PMS8	h) Review of construction documents for move issues such as correlation and documentation of actual/as-built specification and area of spaces involved
PM09	i) Preparation of move packet
PM10	j) Coordination of vendors
PM11	k) Implementation of service and technology bridging
PM12	l) Provision of on-site coordination and Supervision of all move related vendors
PM13	m) Follow-up of vendors
PM14	n) Addressing of surplus items
PM15	o) Ensuring compliance of relocation works with all regulatory requirements

PM and FM tasks in tables 2.1 and 2.2 have been assigned codes which was used for the development of the hypothetical model in Figure 2.6.



LEGEND		
Insignificant Link	Negligible benefits of BIM to the given FM or PM task.	**0**
Very Weak Link	Very weak benefits of BIM to the given FM or PM task.	**02**
Weak Link	Weak benefits of BIM to the given FM or PM task.	**03**
Strong Link	Strong benefits of BIM to the given FM or PM task.	**04**
Very Strong Link	Very strong benefits of BIM to the given FM or PM task.	**05**

Figure 2.6 Hypothetical Model of BIM use for FM and PM showing levels of relevance/benefits and relationships

2.7 Summary of Literature Findings as Reflected in Hypothetical Model

The level of BIM relevance in the different hard and soft FM tasks could vary. From available literature the developed hypothetical model shows that some FM issues will benefit from BIM significantly at both the relocation and lifecycle FM stages. Such tasks include: office space management (FMS01), calculation of costs for goods and services (FMS08), the use of performance management techniques to monitor agreed service levels (FMS12). See Figure 2.6 for further information. However, some FM tasks hypothetically, will benefit little from BIM. Such tasks include: reception (FM05) and liaising with other tenants (FM10) during relocation as the work structure might not be fully functional at this time. Others can be seen in Figure 2.6.

During relocation PM, tasks such as establishing goals (PM01), budget development (PM02), preparation of time plan (PM07) will stand to benefit significantly from BIM as considering the criticality of these elements to PM success (Lewis 2000, Baker et al 2003, Haughey 2008). See Figure 2.6 for other tasks and levels of BIM relevance as determined from literature.

3.0 Single case study: MediaCityUK Building

A case study was carried out based on Yin (2003) single case study design recommendation. However the type of data collected was informed by the proposed aim and objectives of this study. The adopted secondary and primary data sources were literature, interviews, architectural drawings and BIM model. The single case study was approached in the following order: a) Overview based on available literature, interviews and BIM model based on architectural drawings of the university building in MediaCity.

3.1 Overview for the University Building in MediaCity

Planning application was submitted to Salford City Council by Peel Holdings (land owner) in 2007 for the new MediaCityUK building. It relates to three core buildings

which was designed by architects Wilkinson Eyre beside the Lowry in a 200 acre former commercial docks site (Wylie 2007). The University of Salford Building is one out of a number of buildings within MediaCityUK made up of offices, studio blocks, hotels, apartments etc, see Figure 3.1.

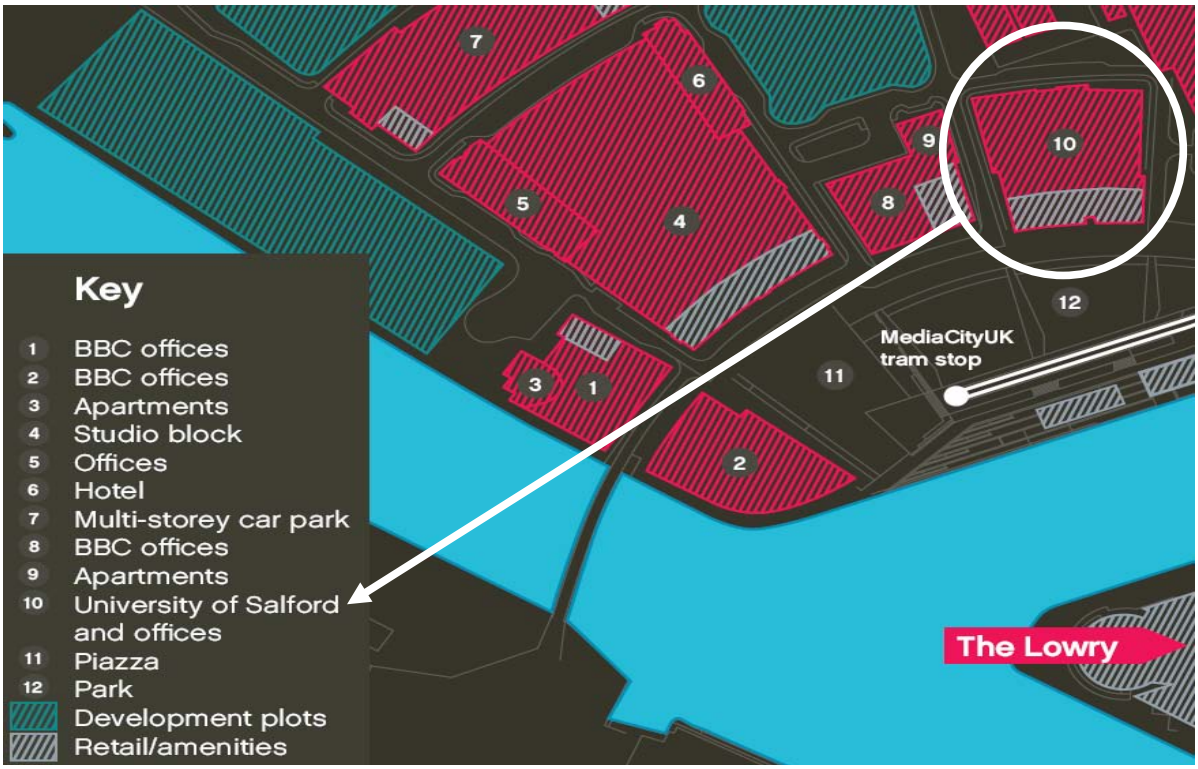


Figure 3.1 Reduced map showing position of the 'University of Salford building MediaCityUK building.

According to the university, the new University hub will comprise 100,000 sq ft over four floors and will be linked to the University's four faculties on the main campus at Peel Park (Russell 2009). It is also projected that over 4,500 staff and students and some key research and business support units could be involved in the move. The University's centre at MediaCityUK was planned to include a broadcast zone, digital media zone, virtual laboratory, digital performance space and creative spaces for use in academic teaching, project-based learning and user-centred design and innovation (Russell 2009). However, the current drawings reflect more functional spaces than listed which suggest updated space requirements for the facility. The city as a whole is expected to start coming to life from spring 2010 (Ozturk et al 2010). The University building in the MediaCityUK, has three double doors and two

single at the east side, three double doors one double swing single door and two revolving doors at the north side, three double doors and three single doors at the west side, no door at the south side.

3.2 University of Salford relocation

The University of Salford is located 1 mile from the MediaCityUK development. As a result of the importance of the move of the University of Salford to Media City, there is the need for relocation PM (Egbu 2010) and FM (Finch 2010) issues to be considered. Relocation will involve movement of light and heavy equipments, furniture will be moved from exiting to new building (Egbu 2010). Personnel and students relocation exercise will also take place as Staff and students will begin using the facilities in September 2011 (Salford University News 2010).

3.3 Interviews

Semi-structured interviews were carried out with four interviewees to explore and analyse particular perspectives on benefits of BIM in FM. The interview findings were further analysed and informed the final analysis. Interviewees were selected from the academia and industry within the built environment with experiences in facilities management and/or IT in the construction industry which includes BIM application.

The first Interviewee (A01) is in the academia with extensive experience in project management. The second interviewee (A02) is also within the academia with extensive experience in facilities management. The third interviewee (I01) is from the industry sector of the industry with a strong background in computer IT within the construction industry. The fourth interviewee (I02) is also from the industry with a good background in facilities management. The fifth interviewee (IA01) is from the industry sector but currently working temporarily in the Academic environment. All of the above interviewees have a direct or remote knowledge of the MediaCityUK building project which is a criterion for selection in addition to individual expertise.

3.3.1 Interview with Academic Interviewee 01 (A01)

Interviewee A01 while commenting on the relocation process PM was quick to highlight that the same core of PM which is planning, monitoring and control, still applies to the management of the relocation process. According to interviewee A01 the unique nature of the relocating institution (the University of Salford) will require that a high level of coordination be adopted to reduce disruption of daily operations and activities such as teaching, research and academic enterprise. Also because of the interfaced nature of some of the university activities e.g. collaborative researches, possible separation during the move could compromise the collaborative efficiency due to absence of proximity. As a result, A01 asserted that for relocation PM efficiency, the key people who will be directly impacted upon by the relocation should be informed giving a long lead time.

A01 also drew attention to the physical infrastructure; the demand on physical spaces and potential of the new MediaCityUK space allocation to satisfy the space requirements of individual schools/departments. In other to be operational, some schools might be used to a much larger space than allocated in the new building hence reduced productivity. Another PM issue pointed out by A01 was that of transportation; safety due to new distance of new property. However it was suggested that alerting the authorities to create safer alternative transportation means would mitigate the potential transportation hazard. A01 described the MediaCityUK as an iconic project hence highlighting the high level of outside interest and media scrutiny hence suggesting a prompt response to financial requests.

When asked about tools and methods used to fulfil PM functions, A01 gave a list of traditional PM techniques and approaches which include Sequencing, Work breakdown structures, Critical path analysis, Network analysis, Bar charts. When asked further with regard to possible IT tools which can catalyse delivery on the above techniques A01 was quick to point out that there are different IT packages for different tasks. The following were listed by A01; a) Critical path analysis can be carried out using Microsoft project, Primavera, b) Risk management using Monte

Carlo Simulation, “At Risk”, c) Methodology for the project can be carried out using Prince 2 (Projects in controlled environment), d) Project cost differential using n value analysis, Project information management systems PIMS, e) Linkage of PM with object oriented issues within a particular project can be carried out using BIM.
A01 went ahead to point out that when adopting software such as BIM, there are issues of conflicting views on whether to go the software route or traditional alternative. And when decision to adopt the software is made the need for capacity and capability to use the software arises. User training on particular software within the given organisation can be both cost and time intensive.

Another potential problem of according to A01 is that of interoperability. A01 also mentioned the various perception of BIM by users; some see it in level one, a basic tool while some see it in level three, strong integrated and collaborative software that actually helps in streamlining the processes and increasing efficiency. According to A01, people who use CAD might say that they are using part of BIM, those who use it at strategic level by bringing people together e.g. PIM might say it’s a means of integrating people who are either collocated or spread around to bring them together in terms of visualisation or virtual reality.

Architects see BIM as one part; design. Programmers see BIM as different because it helps them in sequencing i.e. Project Management; they are not so much interested in the design side. Facilities Managers see BIM as helpful to allow them to articulate exactly what would happen after this movement, employing questions such as; what is the true life cycle of the building? How are we going to monitor the space use (Soft issues) how are we going to do the maintenance (Hard Issues)? How are we going to maximise electricity/energy use? Who will the PM be speaking to?

According to A01, BIM could benefit FM as the University of Salford have a culture of playing around with their spaces, trying to make spaces some worth flexible e.g. changing a meeting room to a workshop 10 years later. However, A01 during the concluding questions mentioned that BIM has been used to address the whole life cycle of other projects but we don’t know how it’s going to be used in this project. It has a role but it depends on the interpretation of BIM and the role of the professionals.

3.3.2 Interview with Academic Interviewee 02 (A02)

A02 when asked about the existing tools normally adopted in FM referred to Computer Aided FM (CAFM) as the main tool. He went further to describe CAFM as a database that is connected to CAD environment which was revolutionary when it came out “20 years” ago. According to A02, FM is linked because of the need to know things such as personnel to populate the space and carry out space planning. When asked about the BIM model similarity with CAFM, A02 mentioned that CAFM has been around much longer than BIM and that BIM is a 3D object modelling tool with building libraries.

A02 pointed out that the relationship with BIM is that you still have that situation where you have a database; BIMS can be driven through database e.g. structural database. The only difference between CAFM and BIM is that the CAD environment is based on intelligent objects and intelligent modelling. Where computer aided FM moves on possibly to BIM. BIM does a lot more in one respect; it’s more sophisticated more of a complete modelling in one respect but in another respect computer aided FM is. According to A02, CAFM works in both environments (2D & 3D) and that’s the reason why computer aided FM has been so popular and that people entering information can populate the database by working in the CAD environment. They put in furniture systems, people, functional zones, and then that would populate the database.

When asked if A02 will propose the CAD FM or a BIM, he suggested that from a practical point of view computer aided FM is a tool that is ready to go, you don’t have to create libraries for it, it’s fit for purpose. However not all computer aided implementation has been successful but in essence it’s designed to do the job that it’s supposed to do. A02’s concern with BIM is that it’s that its providing an answer to a problem might not exist. Commenting on interoperability, A02 pointed out that CAFM runs on standards which are derived from the CAD environment, the exchangeable format AutoCAD.

When asked about peculiarity of MediaCityUK building with respect to FM compared to other buildings, the response from A02 was “No”, pointing out that it’s typical of many modern offices to try to meet very diverse requirements and very high energy demands 24/7 operation.

A02 also pointed out an involvement in a collaborative Case study which adopted BIM (object modelling). The case study looked at Gatwick North terminal, Albert hall, and Krips Kowlswein and we were aware that particular companies were using 3D modelling to try and portray the proposed solution whether it was a new building or remodelling of it. A lot of the case study issues were FM issues. So while the technology is not designed for use by an Fm, it was actually being used to consider Fm issues like security as in the case of Gatwick north terminal. Object modelling was used as a way of having walkthroughs and visualisation as part of stake holder workshops. Security issues were analysed during the case study. There were aspects of the security teams to deal with customs and excise, internal and external security. A02 found it a very effective tool as a way of seeing and identifying security breaches by visualising the 3D spaces. E.g. a possibility of somebody moving from domestic to international customs cleared to non-customs cleared.

When asked if the use of CADFM or BIM would benefit FM in the MediaCityUK building A02 quickly pointed out that it would depend on how much investment of time and effort on the side of the facilities manager to keep that model live and real. If it meant that the FM will be saddled with the responsibility of having to populate the model to be up to date, the CADFM or BIM application could be more of a problem than an asset.

There could be benefits as long as it didn’t come to the facilities manager to maintain the data, as long as it is maintained by a different group of people or there is the resource to do that. There is a cost involved so it’s a question of whether the benefit outweighs the cost. However, it’s like a balancing act.

3.3.3 Interview with Industry Interviewee 01 (I01)

Interviewee I01 who is currently involved in the generation of a virtual reality model of the MediaCityUK building in collaboration with the University of Salford, commented extensively the adopted approach. Accurate input data capture was obtained from the architects and designers directly involved in the MediaCityUK project. The Architects provided the external and internal structural heights while the designer provided the finishes used in the building. I01 also engaged with the main contractor and information was extracted on what their projected achievements were. I01 and team used 3Dstudiomax (Non-BIM 3D visualisation software) to create the model environment and then exported them in a games engine to add a real time element to it so as to test and assign colours and textures. However I01 pointed out that the modelling approach of the MediaCityUK building was cantered around the client's objectives for using the model.

When confronted on level of model input data accuracy, in a scale of 1 to 10, I01 put the level at between 8 and 9 mentioning that there is always a margin for human error and that visualisation tools are not the same as CAD tools in terms of pin point accuracy. However, I01 also pointed out that during information procurement, inaccurate old floor plan for one of the floors was given where a pillar bisects a wall in an entrance area of one of the higher floors. I01 conceded that such error might actually be something that was omitted sometime early in the scheme and the architects and designers might have failed to remove it from one of the floors. 2D drawings received from the architects and designers are viewed in plan form before converting to 3D. This helps I01 and team to work out what goes where and if it doesn't make sense architects are questioned. Another observed error by I01 and team was the staircase which did not didn't line up as they thought it should have, it turned out that one of the measurements was wrong. This was questioned and the staircase was made to line up.

When asked about the difficulties envisaged during the modelling exercise, the response was; 1) the number of iterations which could arise in order to correct an error such as a hanging wall as derived from plan (impossible in reality) as each wall need to be structurally supported, 2) Stake holder observations and proposed

amendments or changes to VR (virtual reality) model. The difficulties were then summarised by I01 as multiple iterations and changing of minds by stake holders. The purpose of the model being generated according to I01 and team was for community engagement, to enthuse local community about the “massive” MediaCityUK development. It can also be used for presentation to international visitors and as a promotional video for the university. Because of the interactive feature it is also proposed to be used as a problem solving exercise. When asked to elaborate on use, I01 went on to emphasise its focus on the community to create awareness on its contribution to the community such as its attraction of large companies like the BBC and their local University. Also I01 mentioned the presence of a piazza with a large public screen, a possible gathering point for people during major events such as Wimbledon and World Cup.

When asked on how the model might be helpful in terms of using the space, the response was that some of the scenarios that are envisaged in that area can be modelled so with a number of key presses a number of options could be iterated. I01 also pointed out that visually explanation can be a very useful way of trying to get some of the messages across. The visuals can be linked to datasets (this is not currently the case). With datasets attached a range of what if scenarios can be investigated visually.

According to I01, it will be desirable to have the VR model to be used in facilities management because of the amount of time and effort that has gone into it. However, I01 was not sure whether they (stakeholders) want the investment of time, resource and ultimately money into creating a backend that will answer some FM questions. Answers which are generated by creating multiple scenarios, not just for professionals in the know with technical terminology, but to be appreciated by non-professionals by saying “look we have run these scenarios, here they are so you can see them and envisage them” and have them press play and it will run through the scenarios and give them an indication of what they are.

When asked if I01 and team would like the model they have generated to be taken into BIM model and expect some stakeholders to use it to enhance facilities management, the response was “it would be invaluable”. I01 went on to emphasise

the potential financial drawback and possible delays in response to request which involves providing a “backend” (database) to the VR model. I01 warned that the front end is a veneer in some respect, while you can represent a range of scenarios, the quality of the backend answering the problems is quite key to using it for facilities management. I01 went ahead to mention that there is also a frame when it can be used for building information management. For example, you may be able to overlay where you are having regular damage; you may have a hand rail that comes up against a place or pulled out of the wall or similar instance, and it may be a bottle neck caused by a chair placed at the end of a breakout area that causes people to swing out and alter the normal exit point. By overlaying that accident data you will be able to see patterns and what the issue is. I01 concluded that the VR model in combination with BIM model will be a very powerful tool.

3.3.4 Interview with Industry Interviewee 02 (I02)

Responding to how FM principles will be applied to the relocation process, I02 started by alerting that the University section of MediaCityUK is a “University” building and not a “departmental” building. This was said to highlight the intended inclusive nature of its use. I02 went further to mention the possibility of using other bigger FM providers to look after the facility as the building houses other tenants such as BBC and the landlord and they will be needing there FM set up. I02 also approached the question from the “service” point of view where it was pointed out that as the MediaCityUK building evolved from the main campus, to service it from the main campus will be an enormous task to achieve. I02 also disclosed some suggestions being put forward to the top management team such as; the security, cleaning, mail delivery and other hard FM issues are being outsourced to an FM company. Suggestions also includes that other soft FM issues such as day to day operation; setting up of rooms for lectures, booking rooms, preparation of rooms for conferences, should be handled by a qualified building manager.

When asked if there were potential peculiarities which can affect FM of the relocation process and the operation of the building, I02 quickly pointed out that apart from the logistics of relocation from the main campus, there technically was not much

difference. However I02 highlighted the advantage of a brand new building from an FM point of view of the MediaCityUK building as opposed to the old main campus building which will require much maintenance.

I02 in response to the hard and soft FM tasks re-emphasised that the MediaCityUK building has landlord and that meant that part of the FM tasks that is being associated are covered under a service agreement with the landlord. I02 went further to give examples such as the FM responsibilities of the MediaCityUK building landlord which involved; external window cleaning, building insurance. These landlord FM responsibilities reduce that of the University. I02 also pointed out that as a result FM responsibility of the University in the MediaCityUK building will then be more focussed on the softer issues such as the catering, the commercial side, and the utilisation (how we use spaces), how it's booked. Hence the overall FM responsibility of the University in the new MediaCityUK building will involve lesser tasks than what is currently operational in the main campus. According to I02, "we won't cut in the MediaCityUK building because that's a landlord issue". He also added "security, external aspect of the building is a landlord issue whereas in the main campus it's the University's issue". Considering design spaces (soft issue), I02 also highlighted the University's flexible working approach (hot desking) where there are large open plan /flexible spaces rather than having dedicated spaces.

I02 mentioned that considerations are being made on whether the system that's used on campus are extended or if a standalone system should be provided in the MediaCityUK building; according to I02, that has not yet been resolved at the time of writing this paper. The current evaluation on the issue is to know if it is practical in terms of its location. An example can be a scenario where a person wants to book a room, would that individual be prepared to go down to MediaCityUK building considering the travel time, the difficulty of access and parking and accessing? According to I02, it's not about having a software package that allows you to carry out booking tasks if no one is ever going to book the spaces in question. According to I02, that's the part that's being evaluated (at the time of writing this paper). If there will be booking of the spaces, the system in the main campus could be extended, if not the system could be operated using a standalone. According to I02, these are the evaluation being done then after that comes the software package. I02 also revealed

that a software package called CAFM which logs FM requests for things that needs fixing is currently in use in the main campus.

When asked about the benefits of BIM in FM, I02 admitted that though the interviewee (I02) had not witnessed the use of BIM in FM, it will have benefits for FM. However I02 was quick to point out that the benefit of BIM in FM is closely tied to how the BIM model is populated. I02 went further to say that that the purpose of the BIM model has to be clearly defined to the person whose been asked to populate it. And the facilities manager definitely have to be clear on what he wants the BIM model to say as an FM tool to make sure that it delivers that part of the project.

I02 also warned that there's a point in time when it's not economically viable to put a project on BIM because it costs more to put it on than the project, but might be economically viable for larger projects. He also mentioned that using BIM might not only provide the benefits of building maintenance but also could allow users to move around the model.

3.3.5 Interview with combined Industry/Academia Interviewee 01 (IA01)

According to IA01 the adopted approach of stakeholders of the MediaCityUK University of Salford building is "...to do things differently", different from how the main University Campus carry out the FM functions. IA01 pointed out that the MediaCityUK building is actually owned by Peel Holdings and the University of Salford as one of the tenants. As a result, Peel Holdings legally have certain FM responsibilities for some of the hard issues which include the exterior fabric of the building, lifts, plants that service the general area. According to IA01, the University of Salford have got the first four floors but then behind is a tower block and the two buildings are integral so in effect there is a joint tenancy situation. Peel in collaboration with University of Salford representative is devising the register for the hard FM and the facilities they will look after. IA01 also mentioned that Peel Holdings are looking forward to developing a service proposition to service certain elements within and outside the building. IA01 suggests the possibility of outsourcing the FM of key areas like room bookings outside core hours. This is because the current

campus runs 9am-5/6pm working hours on the contrary; MediaCityUK is expected to be operational well beyond those hours. IA01 also mentioned that at the time of writing this report, the University FM section concerned with the MediaCityUK building are going through a process of doing the service design and a service specification design. The service specification design will then be given to an FM company through a tender process. Some of the tasks forming the criteria for the service specification are security, reception catering and potentials of room booking, cleaning of the windows and floors, also horticulture of the building and some high end studio equipment which needs maintenance and looking after. IA01 also hinted that due to the experimental nature of the proposed MediaCityUK FM operation model, the model adopted for the current campus will likely not be extended nor adopted for the mean time. Also that if the proposed model proves to be operationally commercially and ethically unviable, the existing processes in the current campus might be reverted to. Because of the initial design concept of the MediaCityUK building ...office building, there is very limited storage capable of holding soft FM supplies. This will imply shuttling from the main campus every half hour which can be very expensive. The proposed FM model might involve working with FM companies taking care of BBC storage as these companies have the system in place within the same building top cater for this. When asked if there were any FM peculiarities in the MediaCityUK building as compared with the main campus, IA01 pointed out that the view of the estate team for the main campus was that the outsource model should be experimented as it will provide a learning platform to new ways of improving efficiencies. The potential benefit is that if the MediaCityUK tenants all work together, they should learn to share their facilities and co-exist which can drive the success of the facility. The different soft FM task to be handled by the University, will be split under the service specification into a line level detail generating a service specification catalogue. According to IA10, the University do not have IT intensions of their own but are willing to go with IT systems the FM companies bring. For room booking, the University will not go with a supplier since they have a room booking system. During school hours, the student services department will run it, outside those hours, the FM Company will run it; though efforts are being made to make it a self service. IA01 pointed out that the open-plan office concept will be adopted for the MediaCityUK building.

4.0 Digital Modelling (Building Information Modelling) of MediaCityUK

To generate the MediaCityUK building for the University of Salford, relevant input master model data was extracted from the drawings provided. It is important however to point out that the extractible data from drawings were limited as a result; functionally identical substitutes were used instead. This will tend to reduce the model representation integrity of the actual MediaCityUK building hence the generated BIM was referred to as a "what if" model. This substitution is not expected to reduce the relevance of findings to MediaCityUK. However, it is also important to point out that according to Smith & Tardif (2009), the comprehensive life cycle BIM is beyond the reach of any end user today because neither the technology nor the market conditions to support it exist.

4.1 MediaCityUK Master Model Data

Master model data was generated from the Architectural documents which include drawings and specifications as it incorporates into the BIM, information from which sub models can be generated. Information sourced was used to create and synchronise with the master model. Where new model data within the master model is required to be created, the specification provided within the drawing was used to determine the Revit type, naming conventions and property data required. Standard property sets are defined for the Revit model and used where applicable and in accordance with this specification.

4.2 MediaCityUK Submodels

In addition to emphasis on information which benefits Facilities management, the MediaCityUK master model can be divided into a number of logical discipline specific sub models. Such sub models could include; Architecture, Land Use, Terrain, Utilities, Structure Mechanical Electrical, Transportation, Equipment, Civil.

4.3 BIM Data Requirement

Building model data shall comply with Revit DWG and DXF interoperable file format, and in accordance with this Specification. Note: Intending users of DXF building model data should consult the University of Salford Facilities Office to confirm the most appropriate data sharing process.

4.4 Revit Model Setup

As proper CAD electronic drawings were not provided, images of the floor plans had to be imported into the BIM interface scaled as accurately as possible and traced using Revit wall objects to generate BIM floor plan layout. The drawing setup was based on the interface provided by the Revit software and took into account scale, layering, BIM data, site/building access, and storey settings. However, due to lack of section drawings the character of some of the lines were not clear hence confusing situations arose where balusters stood the chance of being perceived as walls and vice-versa; however, this was clarified.

4.4.1 Scale and Layering

All models were in metric scale 1:1, with units in millimetres to 0 decimal places. Layering in the Revit project was used to define and group elements of the project.

4.4.2 Revit BIM Data for MediaCityUK

See Appendix B for drawings from which data was extracted. The accuracy of the data will be based on drawings which could differ with as-built drawings hence the need to post construction update of the BIM model.

4.4.3 Site Data for MediaCityUK

The MediaCityUK site data was not made available for this study at the time of this document. An update of the model is recommended as and when more detailed site data/drawing becomes available.

4.4.4 Storey Settings

All storeys' in the BIM model of the University of Salford Building was named in accordance with Table 4.1:

Table 4.1. Storey Settings

Level Code	**Meters above Sea Level**	**Level Name**	**Elevation in meters (FFL)**
Level - G	+24.45	Ground Floor Level: *University of Salford (Studios, Laboratories and unassigned spaces)*	24.45
Level - 01	+28.45	First Floor Level: *University of Salford (Studios, Laboratories, offices and unassigned spaces)*	28.45
Level - 02	+32.65	Second Floor Level: *University of Salford (Studios, Laboratories, offices and unassigned spaces)*	32.65
Level - 03	+36.65	Third Floor Level: *University of Salford Open plan, exhibition, offices, meeting and multi-function areas*	36.65
Level - 04	+40.65	Fourth Floor Level	40.65
Level - 05	+44.65	Fifth Floor Level	44.65
Level - 06	+48.65	Sixth Floor Level	48.65
Level - 07	+52.65	Seventh Floor Level	52.65
Level - 08	+56.65	Eight Floor Level	56.65
Level - 09	+60.65	Ninth Floor Level	60.65

Level - 10	+64.65	Tenth Floor Level	64.65
Level - 11	+68.65	Eleventh Floor Level	68.65
Level - 12	+72.56	Twelfth Floor Level	72.56
Level - 13	+76.65	Plant Floor Level	76.65
Level - 14	+80.65	Roof Level	80.65
Level - 15	+82.65	Roof Top	82.65

Note: Building Storey space allocation can be found in drawings (See Appendix B).

4.5 Spatial Hierarchy

The MediaCityUK BIM model has spatial definitions which could be considered as comprising the following entities: Location Zones, Functional Spaces, Rooms and Places. This could be considered as a form of space classification from largest (building site) to smallest (places within a room). This spatial definition creates a hierarchical structure which helps understanding of the spaces during the project/process management and facilities management exercise.

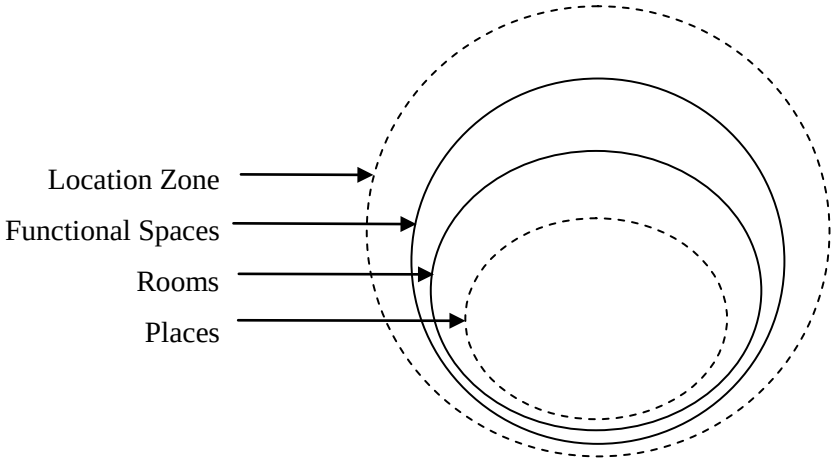


Figure 4.1. Spatial Hierarchy Chart: dotted lines represent spaces without physical boundaries while solid lines represent spaces with boundaries

The Location zone and places which are in dotted lines Figure 9 identifies special entities which are not clearly defined by boundaries or walls within the available drawings. The Functional spaces and Rooms in solid lines identify spatial entities which are defined and have been replicated more accurately in the BIM model.

4.5.1 Location Zones

The MediaCityUK site as contained in MediaCityUK Phase Plan for Phase 1 (See Appendix B) is not well defined. A more detailed site drawing is crucial for identification of location zoning which will help coordinate transport access to MediaCityUK during move.

4.5.2 Functional Spaces

Organizational units within the MediaCityUK University of Salford complex were referred to in this study as Functional Spaces. FS definition was based on drawing interpretation. Table 4.2 below sets out the Current scope. Functional spaces in the MediaCityUK University of Salford Complex are numbered according to the following convention: Storey code><sequential number>. The Functional space (FS) code is an alphabet or/and number with numbers after the decimals which connotes the room/space number e.g. room number 2 for ground floor is reflected as follows G.02. Room names are documented on existing floor plans. See Building Architectural drawings in Appendix B.

Table 4.2 Functional Spaces

FS Code	FS Name|	FS Definition
G.18	Living Laboratory	Living laboratory, ceiling, columns, elliptical wall and multi use area.
G.02	Circulation/Exhibition	Relaxed seating area, access to lifts, green room and stairs to first floor.
1.04	Collaboration Meeting Area	Common open seating area, balusters overlooking ground floor, bridge to studio rooms.
2.21	Vend Breakout	Kitchen, kitchen storage, seating area, resource area.
2.04	Collaborative Space	Relaxed seating area, access to lifts lobby and stairs.

2.08	Open Plan Office	Breakout area, locker storage, columns, curtain walls.
3.26	News Room Workshop	Journalism resource area, relaxed seating area.
3.03	Collaborative Space	Resource area, relaxed seating area, exhibition, access to lifts lobby and stairs.
2.08	Open Plan Office	Breakout area, locker storage, resource storage, columns.

4.5.3 Rooms

Rooms for this study are areas that have been defined by the building's major wall elements etc, (potentially not able to be removed) (Mitchell 2005). Rooms in the MediaCityUK University of Salford Complex, are numbered according to the following convention adopted for as in functional spaces (See section 4.5.2) and are referred to in this section as "ID".

Table 4.3 Rooms

ID	**Types**	**ID**	**Types**	**ID**	**Types**	**ID**	**Types**
	Ground Flr.		**First Flr.**		**Second Flr.**		**Third Flr.**
G.01	*University Lift Lobby*	1.01	Lift Lobby	2.01		3.01	Lift Lobby
G.02	*Circulation/ Exhibition*	1.02	Circulation Breakout	2.02	*Circulation*	3.02	*Circulation*
G.03		1.03	*Stair*	2.03	*Stairs*	3.03	Collaborative Space
G.04	Lobby	1.04	Collaboration/ MeetingArea	2.04	Collaborative Space	3.04	Breakout area
G.05	Reception	1.05	Ops Management FM Office	2.05	Breakout Area	3.05	Open Plan Office
G.06	-	1.06	Cleaner	2.06		3.06	
G.07	Security	1.07	*Bridges*	2.07	Pod	3.07	Study
G.08	Mail	1.08	Lobby	2.08	Open Plan Office	3.08	Hot Room
G.09	Primary IT Systems	1.09	Radio Control Room	2.09		3.09	Hot Room
G.10	Exhibition	1.1	Radio Studio	2.1	Hot Room	3.1	Technician

			A				Suppport
G.11	-	1.11	Radio Studio B	2.11	Hot Room	3.11	Teaching Lab
G.12	Servery	1.12	Sec IT	2.12	Hot Room	3.12	Secondary IT Systems
G.13	Storage/Prep	1.13	TV Control B	2.13	Hot Room	3.13	Lockers/Storage
G.14	House Keeping Storage	1.14	Rack Room	2.14	Secondary IT Systems	3.14	Kitchen
G.15	Furniture Store	1.15	DPL Control Room	2.15	Lockers/Storage	3.15	Exhibition
G.16	Store	1.16	Store	2.16	PC Suite 1	3.16	Vend Breakout
G.17	Green Room	1.17	DPL Lobby	2.17	AV Store	3.17	
G.18	Living Laboratory	1.18	DPL Control Room A (Vision)	2.18	Teaching 3	3.18	Project Room
G.19	DPL Dressing	1.19	DPL Control Room A (Sound)	2.19	Dubbing Theatre	3.19	Store
G.20	Media Store	1.2	Lobby	2.2	Music Computer Suite	3.2	Store
G.21	Lobby	1.21	Lobby	2.21	Vend/Breakout	3.21	Store
G.22	Digital Media Performance Laboratory	1.22		2.22	Cleaner	3.22	PC Suite 2
G.23	-	1.23		2.23	Teaching Playback	3.23	Meeting 1
G.24	DPL Store	1.24		2.24	Channel M Production	3.24	Multi-Faith Room
G.25	Tech Support Office/IT	1.25		2.25	Edit Suite 1	3.25	Seminar Area for Video Editing Suite
G.26	TV Overspill Store	1.26		2.26	Edit Suite 2	3.26	Newsroom/ Workshop
G.27	Lobby	1.27		2.27	Edit Suite 3	3.27	U.C.M.M.R.L
G.28	TV Studio B	1.28		2.28	Library	3.28	Video Proccessing Lab.
G.29	TV Studio A	1.29		2.29	ILS Staff	3.29	Hot Room
G.30	TV Studio Store	1.3		2.3	Quiet Study 1	3.3	Hot Room
G.31	-	1.31		2.31	Server	3.31	Teaching 1
2.32	Staff Area	1.32		2.32	Secondary IT Systems	3.32	Teaching 2
				2.33	Meeting 2	3.33	Resource/ Storage
				2.34	Teaching 4	3.34	
				2.35	Lecture Room	3.35	Teaching Room
				2.36	Audio Post-Production	3.36	Store
				2.37	Lobby	3.37	
				2.38	Sound Booth	3.38	Video Editing Suite
				2.39	Technician Support	3.39	Control Room
				2.4	Lobby	3.4	Msc Student Space
				2.41	Media Tech Lab	3.41	Future

			Expansion
2.42	Store	3.42	Computer Teaching Area
2.43	Store	3.43	Cleaner
2.44	Kitchen	3.44	Live Booth
2.45	Store	3.45	Teaching Office
2.46	Lobby	3.46	
2.47	Quiet Study 2	3.47	Control Room
2.48	*ILS Resource Area*	3.48	
2.49	Meeting 3	3.49	
2.5	Meeting 4	3.5	

Note: Spaces in italics are not included in the “room” definition but were added to create data context. ID “1.05” was repeated as Ops Mgt/FM Office and Student Union Office; “3.25” was repeated as Presentation Space and Seminar Area for Video Editing Suite in drawings provided.

4.5.4 Places

Places are sub-divisions of a room, i.e. the “child” of a Room (Mitchell 2005). The place, within a room, is not coded in the drawing and BIM model. The places within this study are however, identified conceptually by the furniture placements see drawings in Appendix B.

4.6 Architectural Model

Generated BIM model comprises of various building elements which are electronic replicas/representations both in form and scaled down dimensions of the finished MediaCityUK building.

4.6.1 Building Elements

However, it is important that these building elements as a designated discipline shall conform to respective architectural, structural, and mechanical standards for ease of

data exchange. This could involve elements such as Slab, Beam, Column, Wall, Window, Door, Ramp and Stair.

4.6.2 Fire Compartmentation & Fire Zones

Fire zones are important consideration during both the relocation process management and lifecycle facilities management. Temporary and permanent positioning of furniture and equipments can temporarily or permanently compromise the passive fire safety measures integrated within the design.

4.6.3 Furniture

Office furniture types and allocation observed in the drawings provided gives an idea of how which furniture piece is desirable for various functional spaces and rooms. It is important to mention that the exact furniture types in terms of specification weren't available hence furniture pieces as depicted in the drawing were used as guidance. In the BIM model furniture pieces hence were not exact replicas of drawings but generated as close resemblances in function and dimensions. Some of the spaces were not furnished.

4.7 Building Services

Information on building services were not provided and though could be helpful but not critical to meet study objective.

4.7.1 Electrical

The electrical information is not included in the BIM model, this will be done as the information is made available. However, electrical installations consideration within the MediaCityUK building is expected to affect potential furniture placement. During the relocation process, wall sockets and lighting points could restrict or encourage furniture assignment to some "places" within any particular room.

4.7.2 Transportation

Transportation within and outside the building is an important factor. Access routes into the building from adjacent road network could affect relocation process efficiency. The site information have not been included in the BIM model; however, the access points into the building (doors) are included in the model.

5.0 Analysis and Discussion

The conclusion of this paper attempts to analyse the BIM model of MediaCityUK, against tasks required for scheduling the relocation of University of Salford to MediaCityUK which were identified from literature and case studies.
The BIM model revealed a zoning character which was mirrored in the ground and first floor. The central east/west axis on plan view was reinforced with the studio functional spaces (space ID G.28, G.30, G.29 which were designated TV studio B, TV studio store and TV studio A respectively [See Table 5.3 and Appendix B]) and to the north were living spaces and an open plan area to the south. The studios were designed to have double volumes extending to the first floor. The double volume extension and studio function of these spaces suggests light/heavy studio equipments/furniture which was corroborated by interviewee I01 and IA01 which could affect the PM scheduling as the access into G.28 and G.29 goes through G.27 and G.30 which are functional spaces by themselves.

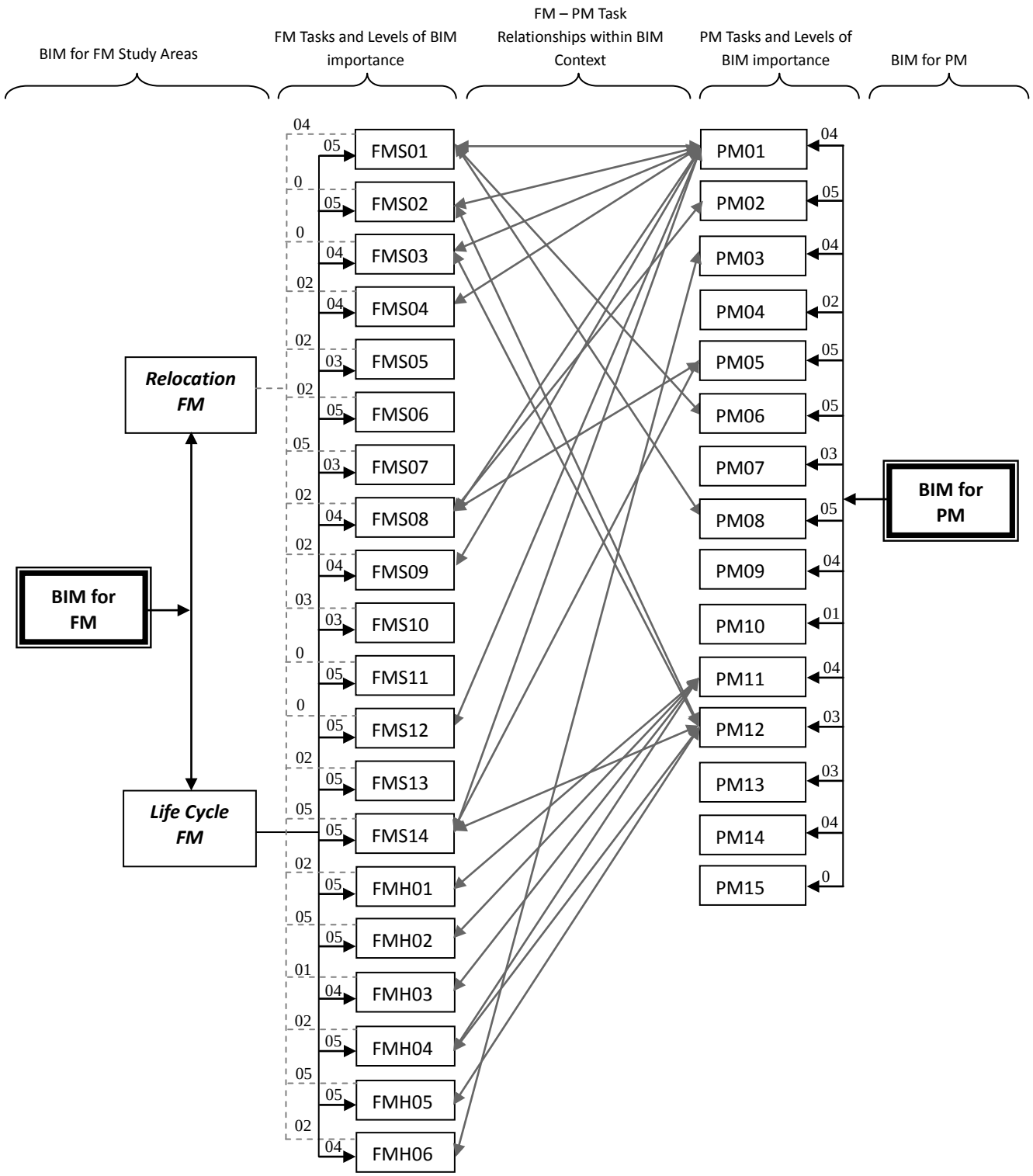
Major accesses into the building were limited to the ground floor east, west and north sides which becomes an important factor when scheduling the movement of furniture into the open plan area. However, the BIM model revealed that the open plan area can be populated but each item has to be dismantled to the minimum door dimension to fit the primary and secondary access double doors.

Areas like the north east section of the BIM model ground floor which is an open area with living laboratory G.18 and exhibition G.10 has a height that extends to the first floor resembling a mezzanine floor and a foot bridge from the mezzanine floor to the east/west axis of the building. This area will require accurate programming to

populate with furniture and a good knowledge of the electrical points is crucial as increased human traffic is expected within this space.

At the second and third floors, the furniture distribution density from the BIM model based on drawings, were significantly higher than that in the ground and first floors. This suggests a significant amount of vertical transport. The BIM model can be of benefit in establishing move goals, determination of move logistics and critical path and provide information to assist in preparation of time plan.

The contributions of BIM in the relocation PM and relocation/operational FM maintenance operations and space management was further systematically analysed based on BIM information. First, a hypothetical model was generated and a comparison was made between the hypothetical model of BIM importance and the model generated after the case study with similar structure (study outcome model). This comparison was aimed at testing the hypothetical model in Figure 2.6 with the study outcome model in Figure 4.2.



LEGEND		
Insignificant Link	Negligible benefits of BIM to the given FM or PM task.	**0**
Very Weak Link	Very weak benefits of BIM to the given FM or PM task.	**02**
Weak Link	Weak benefits of BIM to the given FM or PM task.	**03**
Strong Link	Strong benefits of BIM to the given FM or PM task.	**04**
Very Strong Link	Very strong benefits of BIM to the given FM or PM task.	**05**

Figure 4.2 Study Outcome Model of BIM use for FM and PM showing levels of relevance/benefits and relationships

5.1 Analysis of BIM Benefits in the Relocation PM to MediaCityUK

Items required for scheduling the Relocation to MediaCityUK	*Contribution of BIM Model to Time Planning against each item required*
a) **PM01:** Establishing goals	The process of relocation to the MediaCityUK building will require that goals be established especially due to the large scale of the move. To establish these goals, updated comprehensive and coordinated information about the building is required. To a degree basic information can be acquired from the CAD drawings and specification documents. According to A01 the key relocation goals are: to avoid or minimise disruption of activities, to save time and reduce cost, to avoid health and safety issues during the PM of the relocation. Updated comprehensive and coordinated information" on the building using BIM can provide a wealth of information. BIM model reflects real-time input from participating industry professionals.
b) **PM02:** Development and confirmation of budget	The amount of money that is to be allocated in the relocation process is important. The BIM model which has a schedule of all elements and furnishings involved is expected to aid in information retrieval. I) A CAD 2D or 3D model cannot provide such information simultaneously and as accurately as the BIM model. This is because the 2D drawings in most cases require a separate specification or schedule document which might not be updated while a 3D computer generated model might not have building elements represented in properties and quantities. ii) During the relocation process, the routes to the various storey settings, object spaces and places are important as this will determine the internal transport approach to furniture movement hence cost. As the MediaCityUK BIM model shows the layout of the real building it will be easier to select the most cost effective and time saving internal transport approach/choice. From the SOH Sydney case study, it became evident that inadequate information within the BIM model can compromise this benefit.
c) **PM03:** Preparation of responsibility matrix	During the relocation process, different roles/responsibilities are involved. It is important that these activities are coordinated with clearly defined role for each contractor or vendor. This can be achieved by merely analysing the non-BIM contract documents. The BIM model however will enable the project manager assess the actual work type required for the move using the 3D model of the BIM's accurate element furniture representations. This can include updated accurate electrical plumbing fixture positions that can affect equipment and furniture transport and placement.
d) **PM04:** Development of RFPs (request for	The information provided by the MediaCityUK BIM model can help create more accurate RFP's.

proposals) for vendor participation	
e) **PM05:** Determination of move logistics and critical path	The MediaCityUK BIM model generated was limited to the building structure which also reflects external access and exits along its perimeter wall, the site was not modelled. The move logistics in with respect to transport can be determined by analysing functional space, room and place data within the model. Due to the comprehensive information content of the model (See sections 3.4 & 3.5), the sequence of activities that must be completed on schedule for the entire project to be completed on schedule (critical path) can be determined.
f) **PM06:** Generation of furniture inventory database and preparation and confirmation of move matrix	The crucial element required to generate a move matrix which include furniture inventory and is provided by the BIM model are: *1. Sizes of furniture and building access routes:* As a result of lean production approaches among furniture manufacturers, pre-assembled furniture pieces are gradually being replaced by user assembled units hence a reduction in packaging size for ease of transport. These sizes are important as the access routes within the building to the target space objects have to be adequate in term of size and aspect ratio. *2. Types of furniture:* The function of the building involved determines the class of furniture to be used. Sometimes furniture requirements might be specified by the designer. *3. Vertical transport of furniture:* This involves the relationship between the size and morphology of any given furniture piece and its vertical transport route/access and target functional space, rooms and places (See section 3.5). The BIM model is expected to reveal all stairs and/or lift morphologies and dimensions. This will then guide the choice of furniture *4. Horizontal transport of furniture:* Like vertical transport, the BIM model gives the information of all horizontal transport routes and its relationship between the size and morphology of any given furniture piece which will help generate a move matrix. *5. Positions of electrical fittings.* Knowledge of electrical works positions within the wall and socket points can affect where holes can be created to insert hangers for furniture pieces. Also socket and lighting points which are contained in a BIM model can affect furniture placement within rooms and places. These electrical information are also crucial in generating a move matrix *6. Sizes (width and height) of non-access openings* Information about non-access openings of the MediaCityUK building are reflected in the model and can be used as emergency accesses during move matrix generation. *7. Building fabric data:* This information is accurately represented in the BIM model database and can be

	retrieved when determining furniture types in terms of its short and long term effect on the wall fabric. It is also important to mention that this information includes wall finishes. *8.* However, it is important to point out that the retrievable BIM information during the relocation process management was limited hence the "what if" approach. Certain information types involved in the dynamic aspect of the relocation process such as; "how" the furniture is moved can be unpredictable and dependent on the competence of the engaged labour.
g) **PM07:** Preparation of time plan	The BIM model of MediaCityUK database contains within a single model, information on types and sizes of all spaces within the structure, access routes to each of these spaces, building element and furniture schedules and quantities. With this information it becomes easier to prepare a time plan for the relocation process. However the time plan according to interviewee A01 is dependent on other factors which are beyond the limits of BIM.
h) **PM08:** Review of construction documents for move issues such as correlation and documentation of actual/as-built specification and area of spaces involved	Gathering construction documents from different participating industry professionals can require time and synchronised interpretation of the 2D information can result to interpretation errors due to the number of documents involved. In addition sometimes the as-built drawings are not accurate representations of the original drawings with regards to specification and building dimensions. This was highlighted by interviewee I01 as discrepancies were observed in the drawings used for 3D VR (virtual reality) production; however, these were corrected. The benefit of the BIM model in this context is that the final BIM model reflects the as built information for interoperable reasons with regards to input of participating industry professionals hence a more accurate as-built representation.
i) **PM09:** Preparation of move packet	Information from the BIM model can be used to prepare a move packet. How they are used will depend on the project managers move strategy and objectives.
j) **PM10:** Coordination of vendors	Vendor coordination according to interviewee A01 is important and so is the coordination of the movement of the users (student and staff). The capability of the BIM model to create schedules which are linked to the model makes it easier to coordinate vendors using the BIM model.
k) **PM11:** Implementation of service and technology bridging	Considering IT, the IT facilities present in the MediaCityUK actual building was not represented in the BIM model as a result it is not immediately evident on how the BIM model can benefit in this area during the relocation process. However as a result of the BIM model's capability in represent building components, if the study model is populated with the proposed or existing IT network of the MediaCityUK building, then the BIM model will be in a position to provide some

	benefit in this regard.
l) **PM12:** Provision of on-site coordination and Supervision of all move related vendors	On-site coordination of the relocation process is one of the ways BIM can benefit the relocation project management. As a replica of the real building, the BIM model contains all the desired positioned of furniture and equipments. Also it shows the access routes both in direction and dimension. With such information it is easier to ensure that the right furniture or equipment are positioned in the right functional space, room or place. Also the sequence of the placements can be coordinated and move related vendors supervised from the scheduling capability of the BIM model.
m) **PM13:** Follow-up of vendors	From this study, is not clear how the BIM model can be directly used to follow up vendors. However, the responsibility matrix developed from the BIM can be used for the follow up purpose hence BIM can be said to benefit indirectly in this regard.
n) **PM14:** Addressing of surplus items	It becomes easier to identify surplus items or even avoid them due to the accurate type and quantity schedule provided by the BIM model.
o) **PM15:** Ensuring compliance of relocation works with all regulatory requirements	During the BIM model generation, it is expected that participating industry professionals adhered to relevant regulations and standards hence it is expected that the building itself meets regulatory requirements. However, during the relocation process, the BIM model cannot be used to meet process standards such as transportation safety, this is left to management skills of the project manager.

5.2 Relocation and Operational Building Life Cycle FMS

Soft FM Issues *required for relocation to and operation of MediaCityUK*	*Contribution of BIM Model in FM*	
	Relocation FM	*Operational Life Cycle FM*
i) **FMS01:** Office Space Management: Audit of space utilization, space re-designs. Flexible working and on-going space utilization management.	The capability of BIM as a framework for storing and retrieving information used in construction brings the added advantage of spatial information management during the relocation process. This is achieved through the BIM model's ability to relay spatial information in 2D and 3D. The 3D immersive image alone will result in a limited FM value of the model which was corroborated by interviewee	During the building operational life cycle, the crucial issue with regards to space management becomes the space utilization model. The adopted /experimental space use model for the MediaCityUK by the University according to interviewee IA01 is that of flexible living open plan where active and passive interaction are encouraged and seclusion discouraged. As such it will be required that the above spatial experimentation during the operational cycle of the building be monitored to determine its impact on the building and

	I01. However, the presence of the database (backend) attached to the image will not only allow for visual appreciation of designated function of each space, but will also help space identification using data fortified walkthroughs which can result in more efficient furniture placement and also provide the parametric information required for on-site FM decision making during relocation such as security.	occupants. Under the above circumstance the parameters to observe are the i) Space planning (space functions and relationship of one space to another); Can a function be carried out efficiently with users having access to relevant adjacent spaces without reducing productivity? BIM can provide relevant information for the above as long as the required information does not include circulation simulation of users. The second parameter ii) Space preparation which involves setting up of rooms for lectures, booking rooms, preparation of rooms for conferences, can be improved by applying the BIM scheduling capabilities. The third iii) Spatial assessment to check for things like furniture placement and positions via iterations. At intervals during the operational life of a building rearrangement and replacement of furniture might become necessary. BIM model under a well managed information database can provide information on the number and types of furniture, if and when they are due for change.
ii) **FMS02:** Cleaning	During the relocation process, the cleaning workload is expected to be minimal as a result of the new build status of the MediaCityUK. BIM under this circumstance based on the above assumption, will not be of much use.	However, during the operational life of the building, the entire fabric of the building will require form of maintenance. The doors, windows, floors, etc will require cleaning from time to time. The BIM model being a data fortified prototype of the actual building will have the benefit of showing building elements that require cleaning. The data attached to each element will provide information of the cleaning status and the manufacturers cleaning specification.
iii) **FMS03:** Catering	During the relocation process, it is assumed that there will be few or no one using the facility hence no need for catering. The envisaged catering activities are self arranged small scale catering expected from the vendors/sub contractors carrying out the relocation work.	Using the MediaCityUK as an example, I02 (interviewee) in response to an interview questions pointed out that as the MediaCityUK building evolved from the main campus, to service it from the main campus will be an enormous task to achieve. From the SOH study, BIM was observed to maximising “efficiencies and effectiveness in how SOH makes purchases, avoiding unnecessary purchases. When it comes to catering, this can also apply to MediaCityUK building reducing enormity of the task involved and monitoring the catering process.

iv) **FMS04:** Waste disposal and recycling	Waste disposal is expected during the relocation process as a significant amount of waste is expected to be generated from the main campus when moving furniture documents etc. The BIM model will not be able to capture the potential waste generated from the main campus during relocation. However, due to the capacity of BIM to show spatial relationships, the approximate amount of waste per functional space, room or place, from the main campus can be imputed into the BIM model as room information/notes which can then provide an idea of the size and location of the waste. The constraint is that the BIM model of the main campus will have to be generated which is not cost effective.	However, during the building's life cycle, the type of waste will involve smaller waste over a period of time. BIM model can ensure that waste disposal will be coordinated between departments where possible in order to improve efficiency; appropriately planned and timed so as to reduce waste disposal time. This can be achieved by imputing the average waste expected per functional space, room or place as viewed in BIM interface into BIM database. These values can be calculated over a period of time which helps monitoring the waste disposal.
v) **FMS05:** Reception	During the Case Study, few were mentioned about the reception soft task apart from its functional space in the MediaCityUK BIM model. However, as the receptionists duties involve visitors, and during the relocation process, visitors are often kept off the site for health and safety reasons hence little or no need for BIM application.	When the building is fully operational, the reception becomes a strategic interface between visitors and users hence an increased reception workload. According to literature, business duties of a receptionist may include answering visitors' inquiries about a company and its products or services, directing visitors to their destinations, sorting and handing out mail, answering incoming calls on multi-line telephones or, a switchboard, setting appointments, filing, records keeping, keyboarding/data entry. The Above list of duties involves communication data storage and good real-time knowledge of spaces in the building and its updated functions. The BIM model being a prototype of the building with datasets for each space, will constitute a strategic tool for the receptionist to increase functional efficiency.
vi) **FMS06:** Security	Security during the relocation will be more focussed on activities involved with the move. This form of security will include protecting equipments and goods present during the relocation	During the Operational life of the building when there is full occupancy and functioning of spaces, the building security work load is increased and for a protracted period of time. Under such circumstances, according to A02 BIM becomes a very effective tool and

	rather than operational equipments and personnel as the building is not expected to have resumed function. The BIM model as a result is expected to be of little benefit.	provides a way of seeing and identifying security breaches by visualising the 3D spaces. E.g. a possibility of somebody moving into restricted areas without authorisation etc.
vii) **FMS07:** IT/Switchboard	During the relocation process, the BIM model is expected to be of significant value. During IT installations, the model which has valuable information on each space, electrical sockets telecommunication points, will help in facilitating the relocation and the identification of space types. Made available also are the functions within those identified spaces, and potentially the available telecommunication ports. IT installation process.	When operational, the FM task of IT/switchboard management is expected to require lesser work input except major maintenance works are to be carried out. Under such circumstances, the BIM benefit reduces.
The soft FM tasks listed below (viii to xiv) are management intensive hence its importance during the relocation stage will most likely be limited as the management of the building operation might not have commenced fully.		
viii) **FMS08:** Calculating and comparing costs for required goods or services to achieve maximum value for money	During the relocation process, the major part of this task will likely fall under relocation project management (PM). However, BIM can be used to identify what goods or services are required from its inventory.	When the building becomes operational, BIM can be used to provide accurate inventory information on goods and services when populated regularly. However, for maximum benefit to be derived in calculating and comparing costs for required goods or services, BIM will need to be used alongside computation software.
ix) **FMS09:** Managing and leading change to ensure minimum disruption to core activities	The core activities of the building are expected during the operational life cycle stage. During the relocation process the activities that will be ongoing are that which involves moving equipments and personnel and this falls under relocation PM.	From the interview with IA01 the open-plan space use strategy being adopted for the MediaCityUK building was experimental. The assumption becomes that there is a possibility of change in the use of space. This assumption was corroborated by interviewee A01 which suggests reasonable number of changes during the building life cycle. Under such circumstance, the need to efficiently manage the change becomes crucial. BIM is capable of providing a single, consistent and up-to-date view of all aspects of the facility as illustrated in the BIM study hence can be used to provide vital information which could help avoid conflict in operation during change. Also during change exercise, the visual information is crucial also to help streamline people and equipment traffic

		hence eliminating confusion.
x) **FMS10:** Liaising with tenants of commercial properties	Liaison with tenants can be done before during or after the relocation as corroborated by interviewee IA01. However the objective of the liaison is what places it as a relocation FM activity or a lifecycle FM activity. The BIM model might not play a direct role during liaison activities but can provide important information which could help steer/focus the process.	The same BIM relevance during the relocation process applies for the building operational lifecycle.
xi) **FMS11:** Coordinating and leading a team or teams of staff to cover various areas of responsibility	The BIM model with its wealth of parametric and spatial information can help identify functional spaces, rooms and places. This however will not be very important during the relocation compared to during the life cycle period as the building would not be operational at the time.	When there are significant numbers of staff members, the BIM model can provide information on the building spaces, fabric and quantities but will not be able to generate any form of workflow charts. However in combination with software tool which can execute the latter, BIM will provide tangible benefits.
xii) **FMS12:** Using performance management techniques to monitor and demonstrate achievement of agreed service levels and to lead on improvement	In order to monitor achievement of service levels the building needs to be operational. During the relocation stage the assumption is that this isn't the case. As a result, the BIM relevance at this stage under this criterion is expected to be minimal.	Applying performance management techniques to monitor and demonstrate achievement of agreed service levels will involve both personnel and building information. The BIM model is not capable of simulating the techniques and the set goals. However the BIM model through its rich database and visualization capabilities can provide information which will help make the goals clearer and making obvious areas that needs improvements.
xiii) **FMS13:** Responding appropriately to emergencies or urgent issues as they arise	Emergencies can come in various forms and issues vary. In order to highlight BIM potential benefit, the emergency types and nature of the issues need to be clear. During the relocation process emergencies that do occur will tend to fall under relocation project management.	However, during the operational stage of the building, handling of emergencies that involve building damage can be enhanced by the use of BIM. According to I01, you may be able to overlay where you are having regular damage; you may have a hand rail that comes up against a place or pulled out of the wall or similar instance. Under such or similar circumstance, the BIM model is able to provide information on the type of damage and the location of the damage. In the event of a fire emergency, the BIM 3D model is able to at a glance identify all available fire exits and refuge areas which could be used to inform and guide the occupants to a safe exit. However if the emergency is medical, the BIM model

		becomes limited to providing information which is limited to the building such as location of medical/first aid facilities, nearest access for ambulance and not the nature of the medical condition.
xiv) **FMS14:** Directing and planning essential central services such as reception, security, maintenance, mail, archiving, cleaning, catering, waste disposal and recycling	Directing and planning essential listed central services at this level is purely management and can take place before during or/and after the relocation process. Though the above activity can take place at either side of the relocation process, it is aimed at the operational stage of the building. Because it is aimed at the operational life of the building, it will be considered under the life cycle column.	According to A02 and corroborated by the SOH study, the importance of the BIM model in directing and planning essential central services would depend on how much investment of time and effort on the side of the facilities manager to keep that model live and real. If this is the case directing and planning the soft and hard tasks will benefit significantly from BIM On the other hand, A02 also expressed some fears that if it meant that the FM (who might have other responsibilities), will be saddled with the responsibility of having to populate the model to be up to date, the CADFM or BIM application could be more of a problem than an asset.

Hard FM Issues *required for relocation to and operation of MediaCityUK*	*Contribution of BIM Model in FM*	
	Relocation FM	*Operational Life Cycle FM*
xv) **FMH01:** Maintenance of normal power systems (Electrical substations) and Emergency power	The maintenance of the power systems of MediaCityUK building during the relocation process is expected to be handled by the Landlord of the property according to I02 and IA01. With this arrangement in place, the need for power systems maintenance during relocation will be limited to power systems directly involved in the process provided by the following service providers; contractors, subcontractors and vendors. The use of a BIM model will be left to the relocation service providers. Where such power systems are not stored within a fixed structure and on a temporary basis, it will be difficult to derive much benefit from a BIM model.	When considering the in the maintenance of the power systems within the MediaCityUK building, I02 highlighted the advantage of a brand new building from an FM point of view of the MediaCityUK building as opposed to the old main campus building which will require much maintenance. This is based on the assumption that as the building is new, the power systems are new also. The BIM model in this instance will depend on what has been modelled. If the building BIM model alone has been produced, then we will be talking about how the building room or place that houses the equipment can be identified accessed and observed. This can also include identifying the positions of emergency lighting

		units and accessing their maintenance log from the BIM schedule. On the other hand it is possible to have the equipment itself reproduced in a BIM environment. If this be the case, such maintenance will be beyond the scope of the FM but within that of the manufacturing Engineers.
xvi) **FMH02:** Maintenance of Building Automation System (BAS), security and locks	During the relocation process, it is important to ensure that the locks work properly and those that don't are replaced. The importance is underscored by the movement of furniture and equipments which can be vulnerable to theft. The BIM model has a schedule which has the description, location, number and condition of every single lock in the building. This information will enable the FM staff to accurately identify the description, location, condition/manual of faulty locks and place order for a quick replacement. This approach can be applied to other security components of the building.	The same approach applied during the relocation can be extended for the operational life cycle of the building.
xvii) **FMH03:** Maintenance of Sprinkler systems, Smoke/fire detection systems and Fire Extinguishers, Signage and Evacuation plans	The maintenance of sprinkler systems is not expected to be considered much during the relocation hence little or no relevance of BIM for this function at this stage.	The location description, location, condition of the sprinkler systems, smoke/fire detection systems and fire extinguishers, signage can be imputed in the BIM model. Under such circumstance, it becomes easier for the Fm personnel to identify location of faulty sprinkler systems. During the interview, I02 pointed out that a CAFM software system enables users to report faulty equipments; when this happens, further information and location of the equipment can be quickly retrieved from the BIM model and actioned. The BIM model spatial data will provide an invaluable visual and numerical information system which can help in deciding where to position fire extinguishers and signage.
xviii) **FMH04:** Maintenance of Mechanical and Engineering (M&E engineering)	Similar to FMH01, the maintenance of the mechanical and engineering aspects of the building is not expected to be given much consideration during the relocation process. This is because according to I02 and IA01 such maintenance	Maintenance of M&E during the operational life cycle stage of the building can be carried out without a BIM model. However, when there is a model where the M&E components have been reproduced and information of

	will be carried out by the Landlord. If during the relocation there is a need for its maintenance then it will fall under the maintenance approach for the building when in operation.	each component stored in the database within the master model, it becomes quicker to respond to faults that may arise. For example, if there is a burst pipe in the MediaCityUK building, referring to the model to retrieve information about the burst pipe and visually assessing how the burst pipe will affect other pipe work and the rest of the building becomes a strong facilitator of the appropriate response. The BIM model can also provide similar information for the electrical system; this however depends on how the model is populated.
xix) **FMH05:** Maintenance of Windows and doors	In the event of a broken window or door during the relocation process, the BIM model window and door schedule can be used to identify the broken component location within the building context and component type. The extent of damage can be stored in the BIM model database against its model replica. Information on the history of the component retrieved from BIM and perceived damage can help decide if the solution is to fix it or call for a replacement. Also the BIM model database can create records of window/door fixes and replacements which can help identify patterns thus making it necessary to either continue with a manufacturer or look for another.	Similar to task FMH02, the maintenance of doors and windows in terms of damage can occur during the relocation exercise as well as the operational life cycle stages. As a result, the maintenance approach for the relocation stage can be extended to the operational life cycle stage.
xx) **FMH06:** Checking that agreed work by staff or contractors has been completed satisfactorily and following up on any deficiencies	During the relocation process, this task falls under the relocation PM. However, during the operational life of the building it becomes an FM task.	Assessing for satisfactory completion of works carried out by staff or contractor during the operational life of the MediaCityUK can only derive value from BIM. This depends on what type of works is involved and where it was carried out. If the works involve the building fabric, BIMs accurate geometrical representation of the parts of a building in an integrated data environment can provide useful information with which to compare and assess the completed job.

6.0 Summary

The MediaCityUK building being an iconic development will form an attraction for the people of Salford and beyond. The presence of key organisations like the BBC and the University of Salford already creates a tenant profile which requires management both in terms of the social impact in the local community and the physical impact on the facility. The move of the University of Salford has necessitated a careful and planned process to save time and cost and to minimise adverse environmental, social impacts. As a result the process of relocating from the main University of Salford campus to the MediaCityUK building will be project managed. Also the relocation process and subsequent occupation of the building over time will be subjected to facilities management FM. In other to achieve the target of time and cost savings, efficient relocation and running of the facility, an exploration has been carried out on what benefit BIM will have in each facet of the operation if any.

After the test of the hypothetical model, the FM task relationship with PM task within BIM context remained unchanged; however, there were changes in the study model on the various tasks in comparison with the hypothetical model.

The first objective of this study involved identification of what items are required for scheduling the relocation of University of Salford to MediaCityUK using BIM was addressed in the study. Such items were identified as challenges in section 2.1.1. However, their direct connections with BIM have been found to vary from none (0) to very strong. From the test model, the items/tasks that is expected to have an increased efficiency level from BIM use, corroborated by the test model are: a) Establishing goals. The goals of the entire relocation project whatever it is, need to be closely tied to the character of the MediaCityUK building and will include cost and time savings. Interviewee A01 and corroborated by AI01, the space use model of the MediaCityUK building by the University is that of open plan. This approach, though falls more under FM will tend to play a major role in defining the relocation PM goals. The BIM model's walkthrough attribute will assist the PM in having a virtual tour of the building to visually assess key considerations during relocation to be included in the project goals. Also the BIM model's in addition to its quantification and scheduling capability will help in setting cost and time targets. b) Slightly similar to

the later section of ‘a’, involves the development and confirmation of budget. The BIM models accurate quantification and scheduling attribute will provide detailed information on number and types of furniture to be moved and other cost intensive decision making considerations such as work breakdown structures, critical path analysis and execution. c) Preparation of responsibility matrix. In order to outline responsibilities, comprehensive information on the work to be carried out need to be defined. The BIM model as a prototype of the actual building will provide information on the equipments, furniture, access routes within the building, safety systems; etc which will enable virtual execution of the project hence a responsibility matrix can be prepared prior to actual execution of the relocation project. Details of the PM items can be found in section 2.1.1 and graphic representation showing levels of BIM relevance in figure 4.2.

From available literature, time planning in project management depends on the expertise of the project manager. Such expertise invariably is dependent on clients expected performance level, cost/available project finance and scope of the project. The usefulness of the BIM model under this circumstance will be linked to accurate determination of the project scope and illustration of expected performance level. The ability of the BIM model to provide virtual prototype of the completed project enables the stakeholder or client to determine the desired performance level and/or scope of the project. The cost of the determined performance level and scope for the project can also be reproduced in real-time by BIM with proper quantity input which will assist the stakeholder to balance desired performance level and scope against available funds for the project. The cost however in this context of time saving goes beyond the limits of BIM model capability because what affects time savings significantly is more of the availability of the funding for the project than the determination of the cost.

The use of BIM for maintenance operations of the MediaCityUK building will depend so much on how the model is populated, the available information on electrical, M&E, and machinery/plant issues within the model how this information in the model is maintained over time. If the above is the case, The BIM model will serve as a virtual replica of the building with important information on the maintenance histories of each component within the building. In the event of a maintenance problem e.g. in

the plumbing system, the BIM model can provide visual information on the location of the fixture, how the fixture relates to other fixtures and the building as a whole, where the fixture type have been used in other areas of the building in order to inspect for potential damage. Such information will make it easier for the FM team to identify and rectify. The BIM benefit in this regard is limited to the type, quantity and quality of information within the model. Also there is a time when it will not be economically viable to adopt the BIM approach such as its use in relatively small projects which requires high information quality; also in a situation where extensive training of its users will be required for a project hence compromising time and cost. See figure 10 for levels of BIM relevance from test model.

The MediaCityUK building is made up of open plan areas/functional spaces, closed spaces/rooms and spaces which extend vertically to the next floor/voids. In 2D representation, these spaces become difficult to understand and articulate with regards to its designated use. With ordinary 3D CAD representations, the spaces can be visually appreciated with no specification details and quantities attached. During decision making on space use, the designer/FM representative will need to convey proposed ideas to the stakeholder or client both visually and technically. This will enable the stakeholder/client to make a visually and technically informed decision on space use. The BIM model will enable the FM manager identify spaces, its uses, the wall/building component that the space is made of, how one space relates to another, what within a space can potentially inhabit its function such as a high-level wall projection in a high traffic corridor etc. The following recommendations are proposed. i) More resource be invested into producing a more comprehensive and well populated MediaCity BIM model as a strategic information database for all round maintenance of facility, ii) The life cycle FM expectations of MediaCity UK be carefully monitored as dynamic use of spaces could create new FM challenges.

Appendix A

A.1 Interoperability Definition

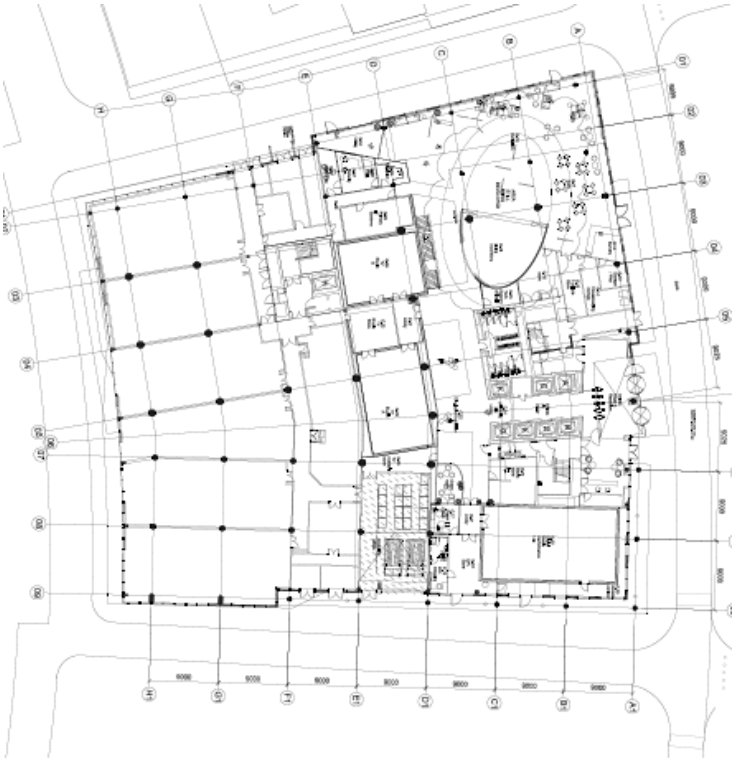
Ability to work with each other. In the loosely coupled environment of a service-oriented architecture, separate resources don't need to know the details of how they

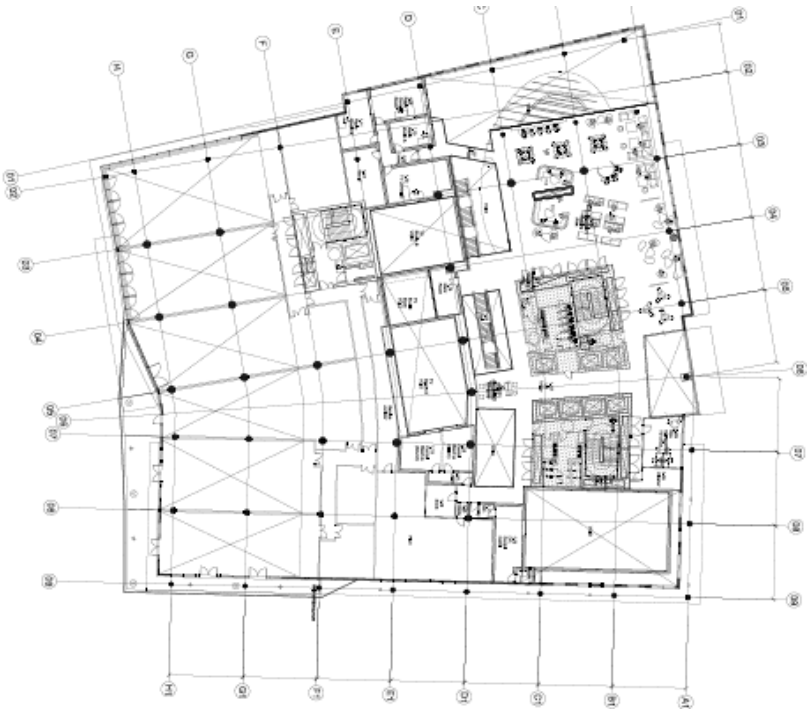
each work, but they need to have enough common ground to reliably exchange messages without error or misunderstanding (Loosely Coupled 2010).

Appendix B

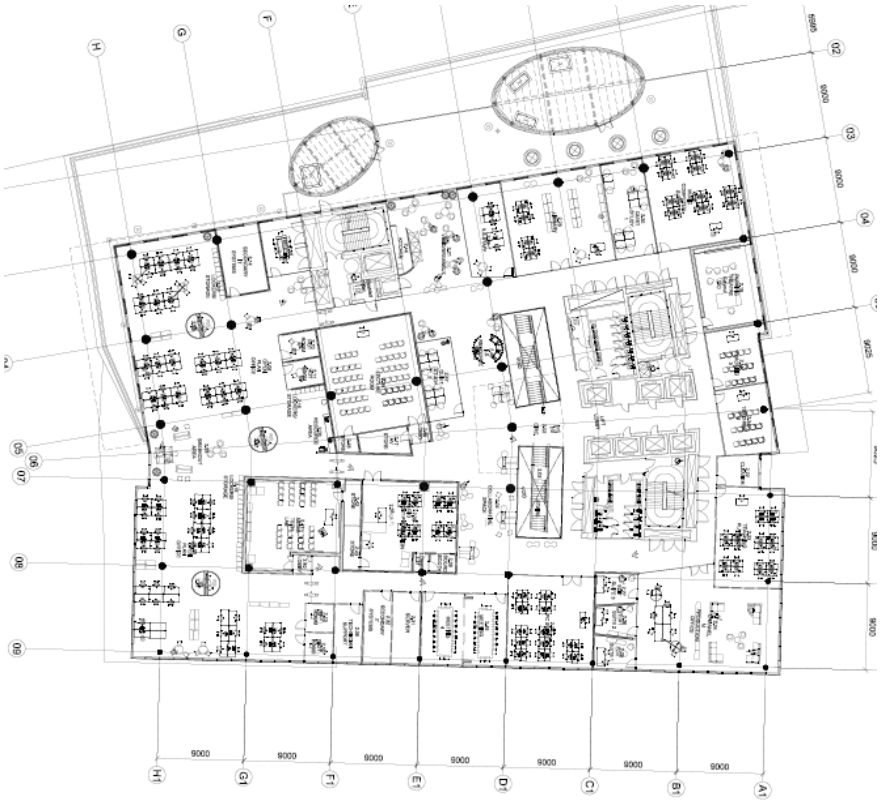
The drawings provided in this appendix are examples as all the drawings if included will significantly increase the size of this document.

B.1 Electronic 2D Drawings Provided





a)

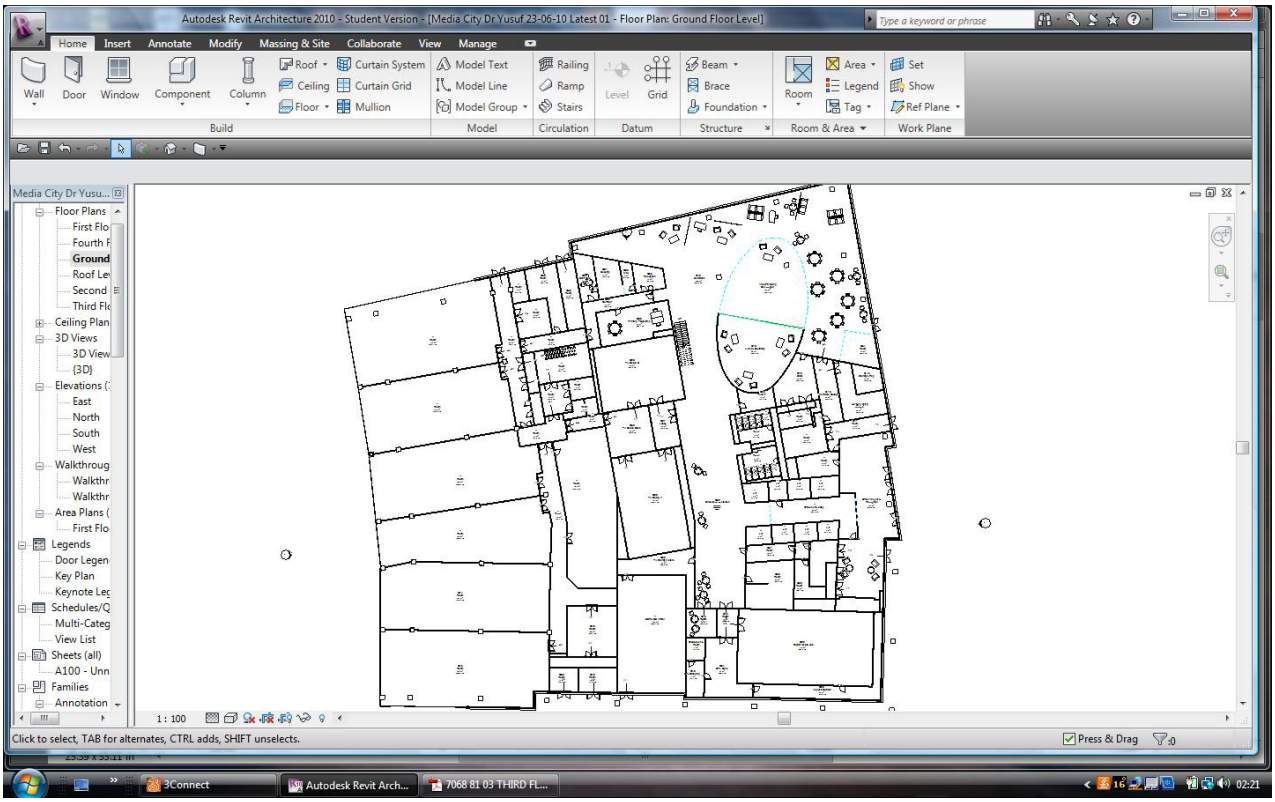


b)

Figure B1.1 a) Ground Floor Plan b) and First Floor Plan

B.2 Revit 2D BIM Drawings Generated

a)



b)

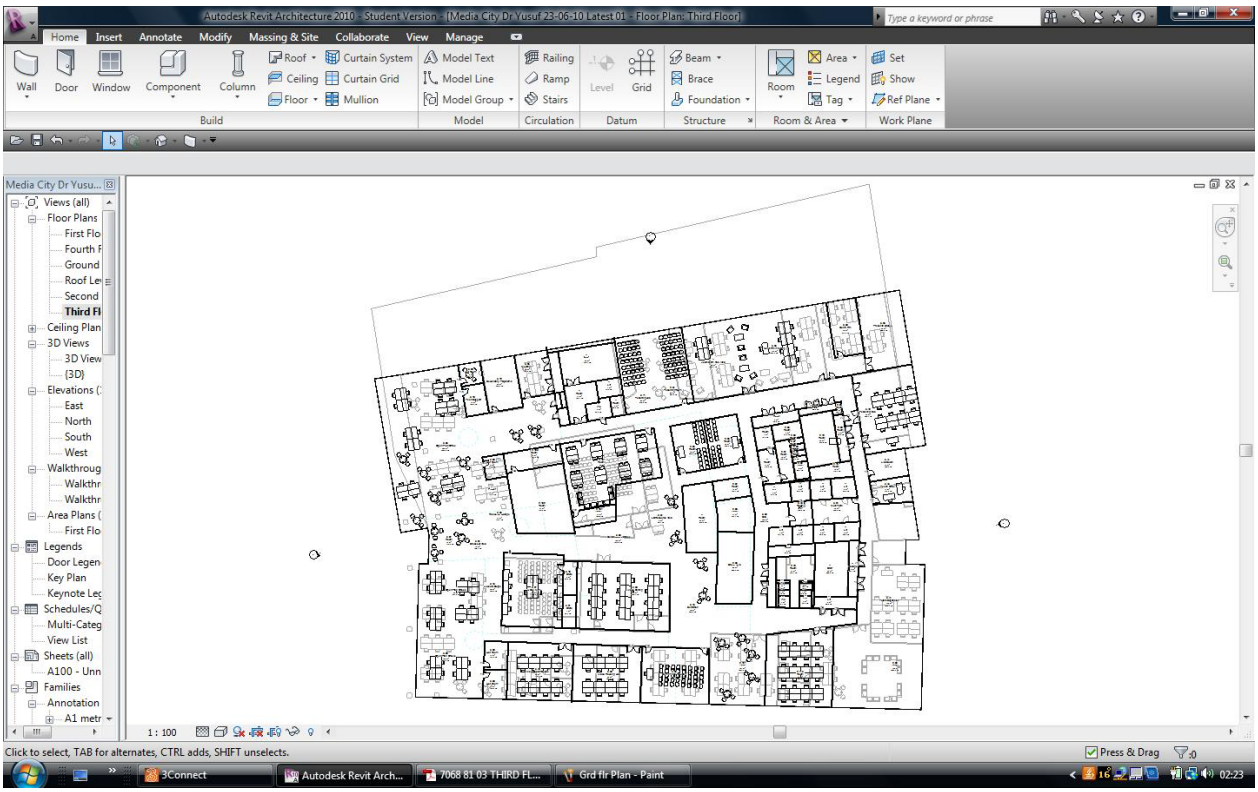
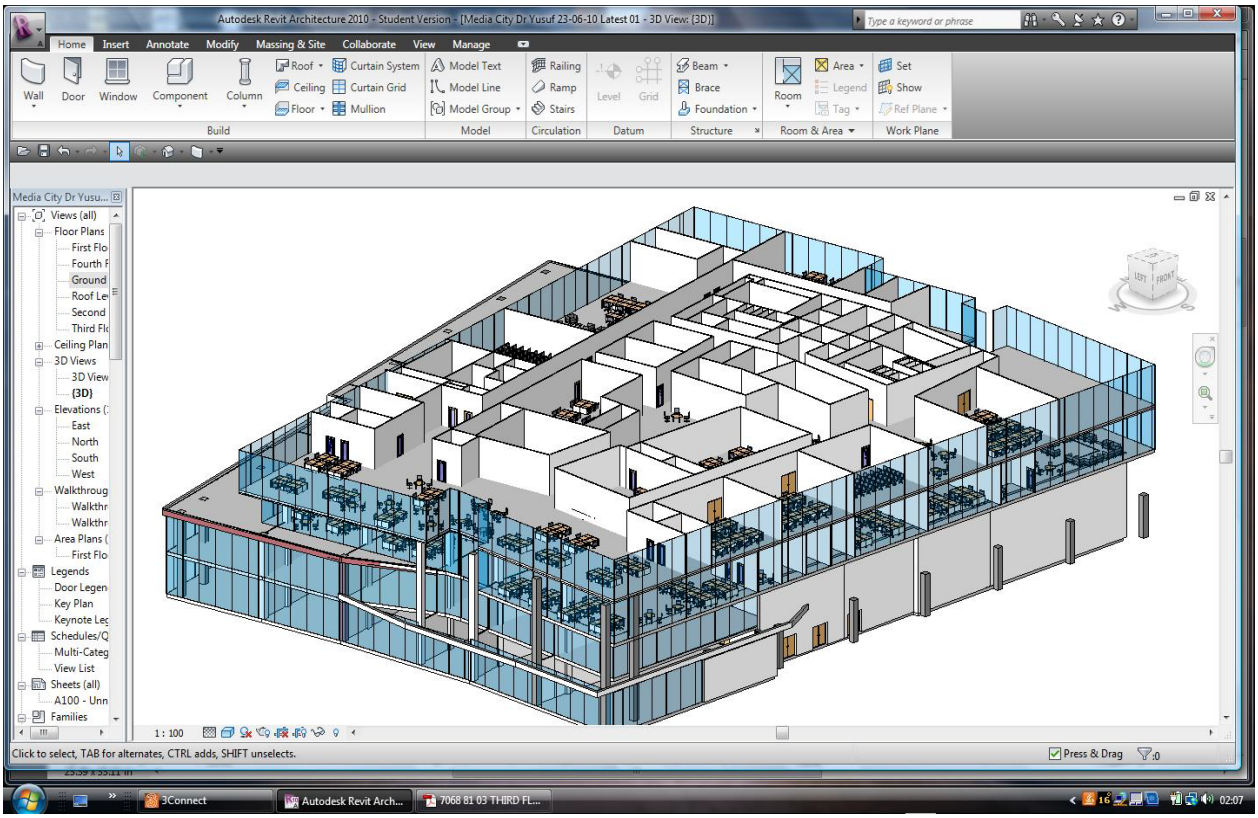


Figure B2.1 BIM Generated: a) Ground Floor Plan b) and First Floor Plan

B.3 Revit 3D BIM Drawings Generated

a)



b)

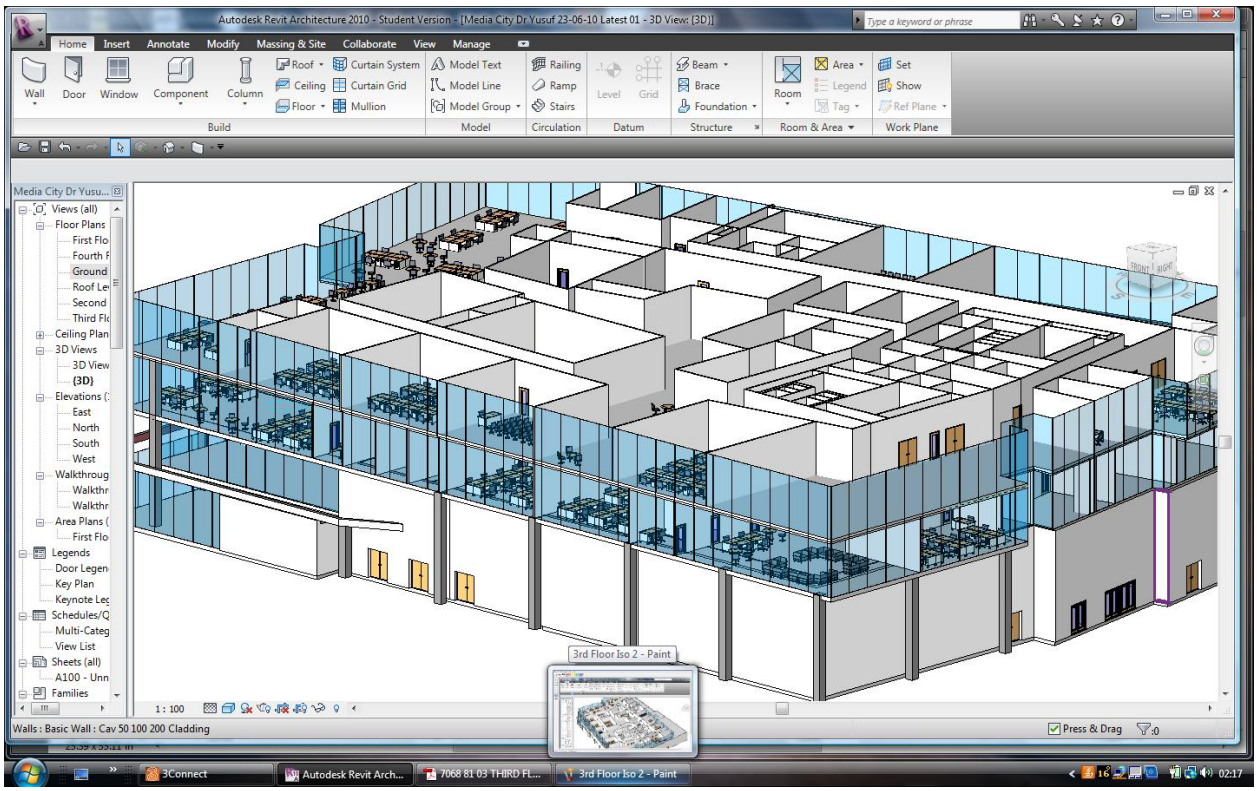
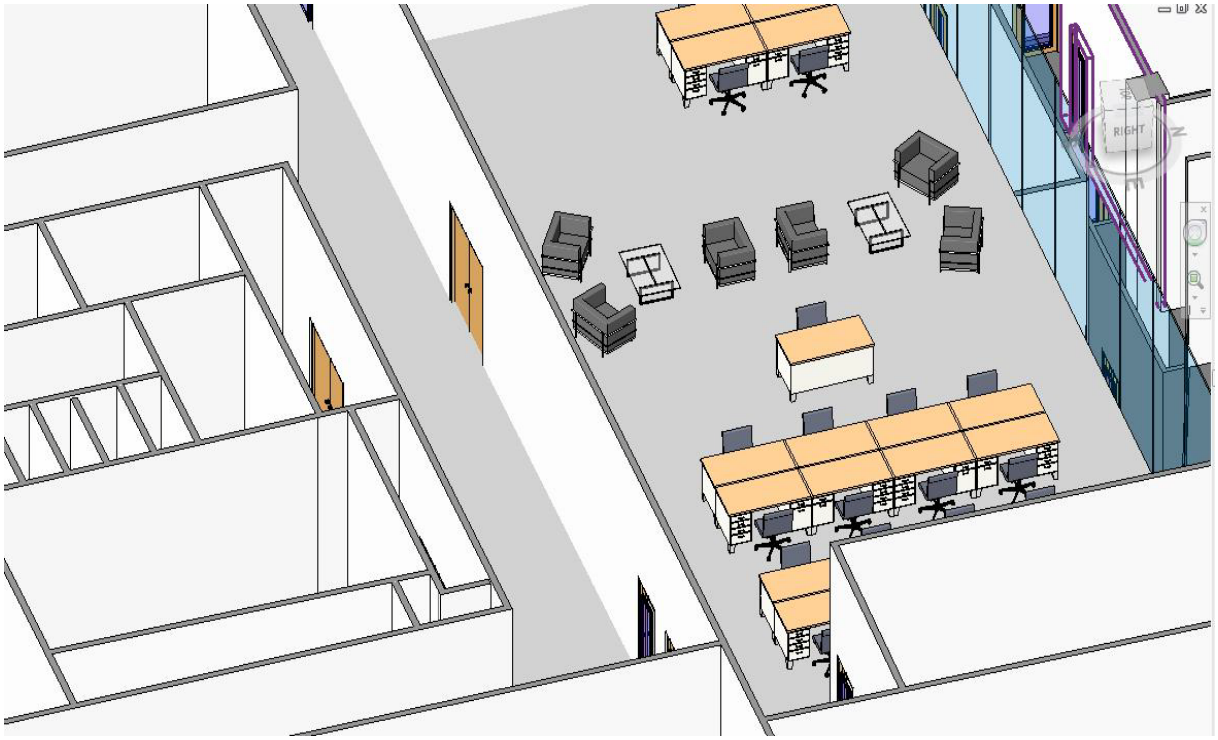


Figure B3.1 BIM Generated: a) Third Floor Isometric 3D South East View of Plan
b) Third Floor Isometric 3D North East View of Plan

c)



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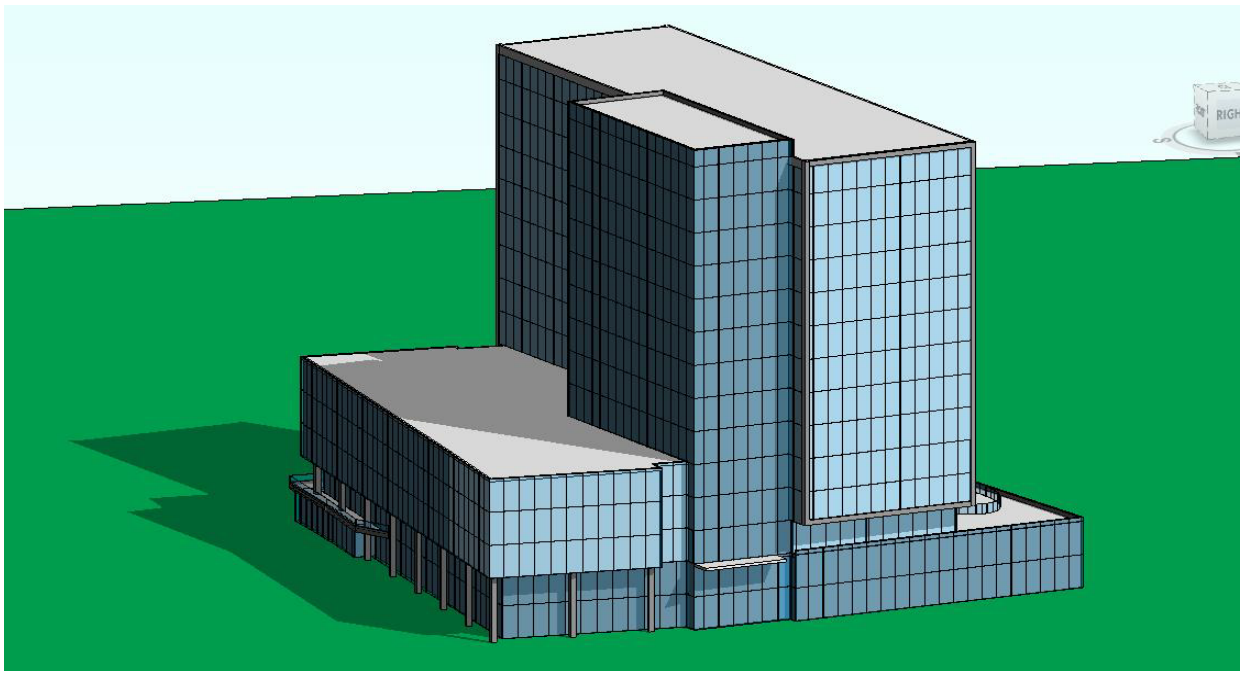
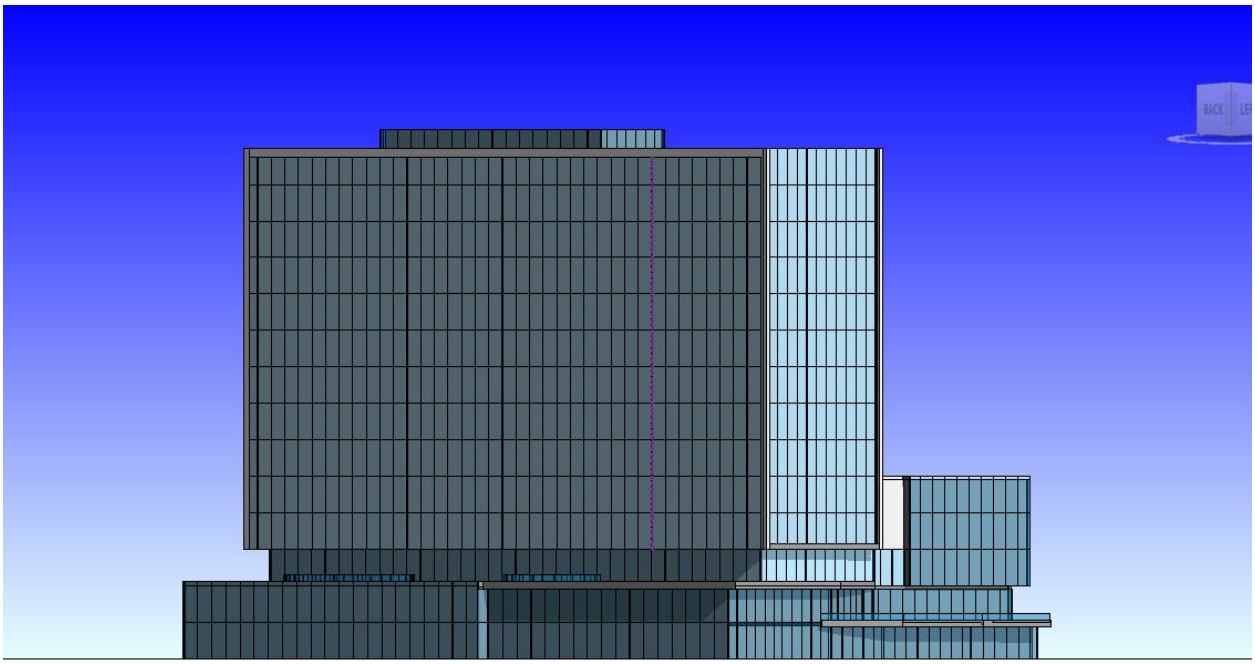


Figure B3.2 BIM Generated: a) Third Floor Isometric 3D South East View of Plan
b) Third Floor Isometric 3D North East View of Plan

e)



f)

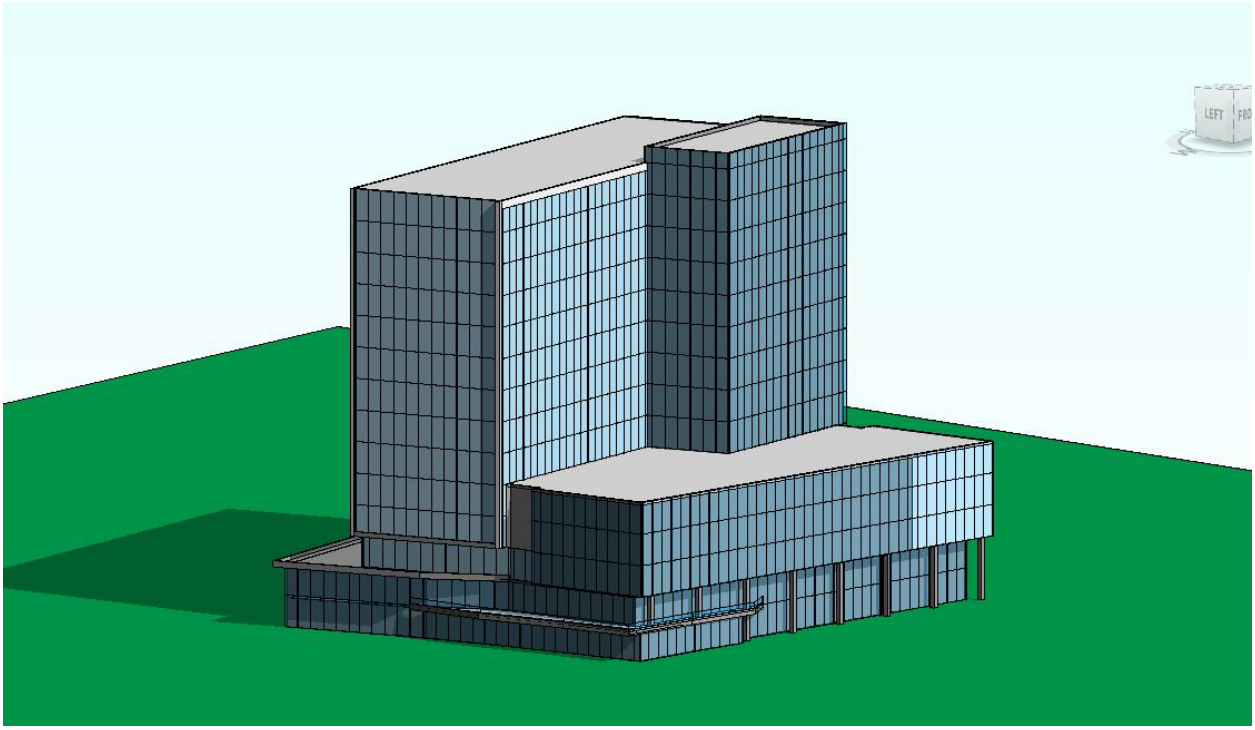


Figure B3.3 BIM Generated: e) Exterior South West Elevation View
f) Exterior Isometric 3D South East View

g)

h)

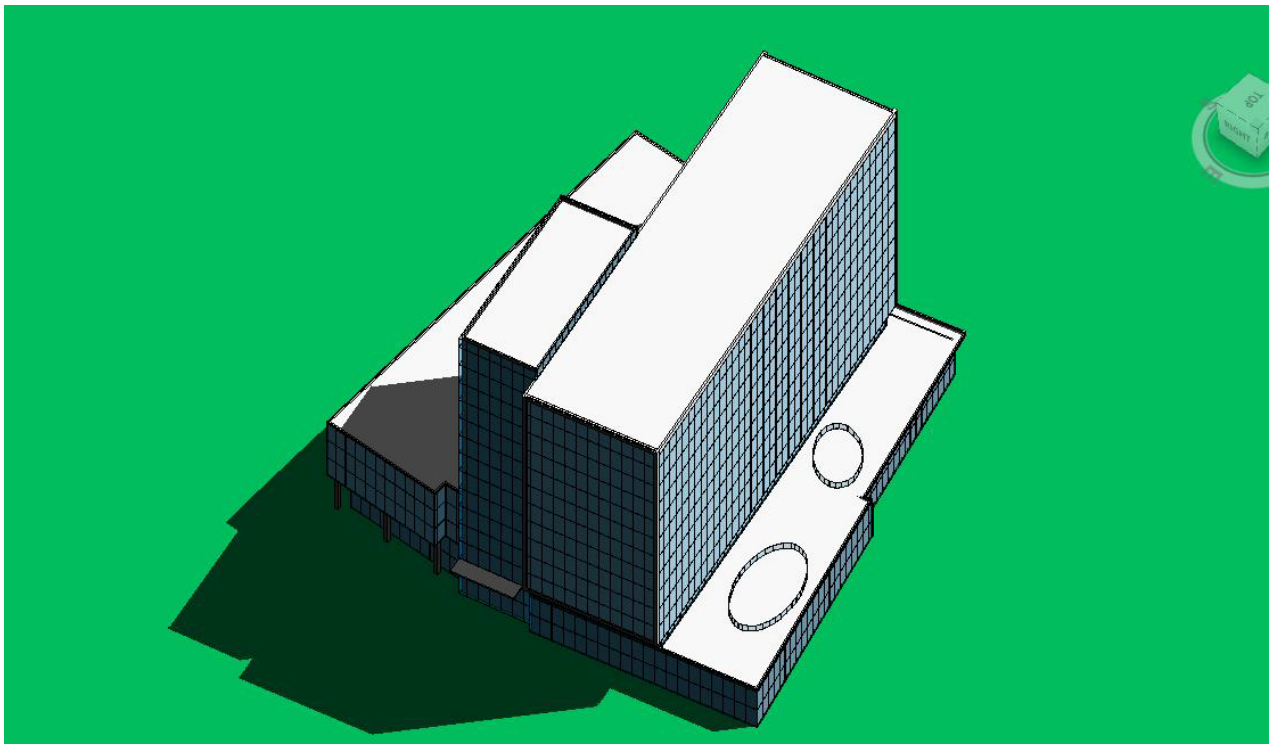


Figure B3.4 BIM Generated: e) Exterior North East Elevation View

f) Exterior North West Birds Eye View

Appendix C

C.1 References

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