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Vielen Dank an alle KollegInnen des IFM für die Mithilfe bei der Organisation!

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Vorwort des Herausgebers

10. Journal für Facility Management: Wissenschaft trifft Praxis

Die Weiterentwicklung der Themen im Bereich der FM Forschung zeigt sich deutlich in dieser Ausgabe. Nicht mehr die Optimierung des operativen Betriebs steht im Mittelpunkt sondern Managementthemen. Sie reichen von der systematischen Instandsetzungsplanung über neue Möglichkeiten im Datenaustausch im Planungs- und Nutzungsprozess bis hin zum Einfluss von FM und Green Building Zertifikaten auf den Wert von Immobilien.

Im Bereich Instandsetzungsplanung wird gerade in wirtschaftlich herausfordernden Zeiten gerne der Rotstift angesetzt. Die Auswirkungen auf den Gebäudebestand sind nicht sofort erkennbar und die eingesparten Mittel tragen direkt zum Unternehmenserfolg bei. Wie kann FM nun dem Vorstand einfach ohne großen Erhebungsaufwand den Bedarf „nachhaltig“ begründen? Der erste Artikel gibt einen wissenschaftlich fundierten Ansatz dafür.

Im zweiten Betrag werden Möglichkeiten der neuen, alten Technologie Building Information Modeling für die Nutzungsphase aufgezeigt, aber auch die Hindernisse für den Einsatz dieser objektorientierten, programmunabhängigen Datenstruktur für den Austausch von Gebäudemodellen beleuchtet.

Ein weiterer Beitrag analysiert die Möglichkeiten von BIM, bessere Entscheidungsgrundlagen für Asset und Facility Management zur Verfügung zu stellen.

Der letzte Beitrag geht noch einen Schritt weiter und zeigt den Zusammenhang zwischen FM sowie Green Building Eigenschaften/Nachhaltigkeit einer Immobilie und ihrem Wert auf. Dieser konnte im Rahmen der Studie eindeutig bewiesen werden. Auch wenn es sich hier um eine Case Studie aus Asien handelt, kann man diesen Trend auch in Europe zunehmend erkennen.

Diese wissenschaftlichen Beiträge in der aktuellen Ausgabe des IFM Journals zeigen ihnen fundierte Ansätze zu diesen Themen aus der Sicht der Wissenschaft. Die sich jedoch leicht in der Praxis umsetzen lassen.

An dieser Stelle möchte ich mich bei den Forschern aus aller Welt bedanken, die einen Beitrag eingereicht haben. Mein Dank gilt aber auch meinen Kollegen vom Scientific Committee. Sie haben in einem Double Blind Review-Verfahren zuerst die Abstracts und dann die Papers begutachtet und den Forschern mit Anregungen geholfen.

Die hohe Ablehnungsquote, die namhaften Mitglieder des Komitees und der damit vertretenen Universitäten, sowie das beschriebene Verfahren machen die Beiträge zu fundierten Ansätzen für praktische Projekte in den oben genannten Bereichen.

Im 10. Journal für Facility Management finden Sie in der Folge die ausgewählten Beiträge zu folgenden Themen:

- Instandsetzungsplanung
- Building Information Modelling und
- Einfluss von Green Building Features auf die Bewertung von Gebäuden

Zudem möchte ich mich auch bei meinem Team bedanken, vor allem bei Frau Mag. Barbara Gatscher, MMag. Michael Zobl und DI Christine Hax, ohne deren großen Einsatz das Journal für Facility Management nicht in dieser Form vorliegen könnte.

Mit freundlichen Grüßen aus Wien wünsche ich Ihnen wieder viel Vergnügen bei dieser Lektüre und freue mich schon auf zahlreiche Einreichungen zum 8. IFM-Kongress 2015.

Ihr

Alexander Redlein

Head of Scientific Committee

Für meine Familie vor allem Barbara

Caroline Sidonie und Alexander David

Wissenschaft trifft Praxis I:

Instandsetzungsplanung

Methodik einer systematischen Instandsetzungsplanung am Beispiel von Spitalgebäuden

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Kurzfassung

Heute werden Instandsetzungen von Gebäuden und deren Elementen oft ungeplant, nicht abgestimmt oder zu spät ausgeführt. In der Folge ist eine mehrjährige Budgetplanung kaum möglich. Bauobjekte und deren Elemente erreichen zudem oft einen Zustand, welcher nicht mehr den Nutzungsanforderungen entspricht. Dies führt zu Einschränkungen in der Nutzbarkeit, unnötig hohem finanziellem Aufwand für ungeplante Instandsetzungen und die Projekt- und Arbeitsplanung ist erschwert.
Mit dieser Forschungsarbeit wurde eine neuartige Methodik für die mittelfristige Instandsetzungsplanung inklusive mehrjähriger Projekt- und Budgetplanung entwickelt. Bei dieser Methodik wird ein Gebäude detailliert in Elemente gegliedert. Der innovative Ansatz ist, dass die Bauelemente nicht periodisch inspiziert werden, was bisher einen unverhältnismäßigen Aufwand bedeutete. Der optimale Zeitpunkt für die Inspektion wird pro Element über das Alterungsverhalten der Bauteile errechnet. Damit müssen diese nur 2- oder 3-mal über die Lebensdauer inspiziert werden. Diese genaue und mit wenig Aufwand machbare Zustandsbewertung erlaubt eine zuverlässigere Planung der Instandsetzung als es bisher möglich ist.

Keywords: Instandsetzungsplanung, Gebäudezustandsbewertung, Budgetplanung, Methodik

1. PROBLEMSTELLUNG

Heute sind sich die FM-Fachleute einig: Lebenszyklusorientiertes Immobilienmanagement muss angestrebt werden (Diederichs, 2005). In der Umsetzung scheitern solche Projekte jedoch häufig. Die Alterung eines Gebäudes und seiner Elemente ist nur schwer prognostizierbar und abhängig von Nutzungsintensität, Qualität der Instandhaltung und Umgebungsbedingungen (Lavy & Shohet, 2007). Eine Zustandserfassung ist aufwendig und wird selten systematisch durchgeführt.

Der Fokus dieses Papiers richtet sich nicht auf die operativen Betriebskosten und die Instandhaltung, sondern auf die Instandsetzung (Begriffsdefinition nach DIN 31051 (Deutsches Institut für Normung e.V. (DIN), 2012), vgl. auch SIA 469 (Schweizer Ingenieur- und Architekten- Verein (SIA), 1997)).

Angegangen wurde diese Problematik erstmals von J. Schröder, Hochbauinspektor des Kantons Zürich, welcher Studien zur Zustandsbewertungen von Gebäudebeständen durchgeführt hat (Schröder, 1989). Das Thema wurde vom Bund zwischen 1990 und 1996 im Rahmen des Impulsprogramms IP-Bau (IP-Bau, Bundesamt für Konjunkturfragen, 1995) aufgenommen. Die von Wirtschaft, Hochschulen und Bund erarbeiteten Erkenntnisse bilden bis heute die methodische Grundlage zur Planung von Instandsetzungen im nationalen wie auch internationalen Umfeld (Christen, Schroeder, & Wallbaum, 2014). Hauptnachteil diese Methode ist, dass sie insbesondere für Wohngebäude geeignet ist und für andere Gebäudetypen wie zum Beispiel Büro-, Industrie- und Spitalgebäude nur bedingt anwendbar ist. An der ETH Zürich wurde von Prof. Paul Meyer-Meierling kurz darauf ein Forschungsprojekt lanciert, mit dem Ziel die Instandsetzungen nach IP-Bau wirtschaftlich zu optimieren (Christen & Meyer-Meierling, 1999). Das Nachfolgeprojekt von IP-Bau war DUEGA (Diagnosemethode für die Unterhalts- und Erneuerungsplanung verschiedener Gebäude-Arten) (Wright-Jungen, 1998). Ziel von DUEGA war es, IP-Bau weiter zu entwickeln, Nachteile zu beseitigen und die Methodik auf jegliche Art von Gebäuden zu erweitern. Die Methodik war ähnlich gewählt. Die Gliederung basierte auf der Elementkostengliederung (EKG) (Schweizerische Zentralstelle für Baurationalisierung CRB, 2000). Im Ausland wurde IP-Bau mit dem Projekt JOULE weiterentwickelt. Aus beiden Weiterentwicklungen entstanden Softwareprogramme zur Anwendung der Methodik. Als Beispiel ist die von der europäischen Union geförderte Software EPIQR (Energy performance indoor environmental quality and retrofit) zu nennen (Trümpy, Briccola, & Genre, 2001). Diese ist für Wohnbauten prädestiniert (Calcon, 2015). Heute gibt es allerdings national wie international keine anerkannte Methodik, die für komplexe Bauten geeignet und in der Praxis anwendbar ist, obwohl unbestritten ist, dass dafür ein Bedarf besteht (Bartsch, Kalusche, & Rausch, 2008) (Dhirendra, Sujeeva, & and Indubhushan, 2010).

Grösse und Inhomogenität eines Nichtwohn-Gebäudeparks können die Planung wie auch die Instandsetzung selber mit heute bekannten Werkzeugen zu einem unüberblickbaren Problem werden lassen. Anstatt vorausschauend zu handeln, werden jeweils nur die dringendsten Sanierungen ausgeführt und eine vorausschauende Instandsetzung erfolgt nicht. Vor allem bei technischen Anlagen kann dies auch zu Ausfällen führen. Im schlimmsten Fall bedeutet dies, dass ganze Gebäudeteile geschlossen werden müssen oder mit massiven Komforteinbussen gerechnet werden muss.

Mit der Einführung des DRG – Systems, einem fallbezogenen Pauschal-Abrechnungssystem (Art. 49 KVG, (Bundesgesetz über die Krankenversicherung (KVG), SR 832.10, Stand 11.

Juli 2013)), sind die Spitäler neu gezwungen, ihre Aufwände den Leistungen korrekt zuzuordnen. Bis anhin wurde der Instandsetzungsaufwand pauschal ein bis zwei Jahre voraus budgetiert und aus der laufenden Rechnung finanziert. Häufig wurden Instandsetzungen aufgeschoben, was zu einer ungenügenden Instandsetzungsrate im Spitalwesen führt (Keating & Alder, 2013). Instandsetzungsstau sowie fehlende Rücklagen sind die Folgen. Auch die neue Verantwortung für die Lebenszykluskosten durch die Spitäler muss berücksichtigt werden, was in ganz Europa der Fall ist (Bjorberg & Verweij, 2009). Dieser Sachverhalt trifft analog oft auch für andere öffentliche und private Immobilien-Portfolios zu (Schedle, Fischbacher, & Leu, 2006) (Stratmann & Stibbe, 2014).

2. ZIELSETZUNG UND BEDEUTUNG DES PROJEKTES

Die neu entwickelte Methodik zur Instandsetzungsplanung soll eine systematische, aber einfach anwendbare Instandhaltungsplanung für etwa 4 Jahre im Voraus ermöglichen. Sie soll auf einer möglichst präzisen Zustandserfassung der Gebäude basieren, also Bottom-up erfolgen. Diese Zustandsbewertung ist so zu vereinfachen, dass sie machbar wird, was die grösste Herausforderung darstellt. Die knappen Ressourcen der technischen Dienste müssen berücksichtigen werden. Zudem ist eine universelle Anwendbarkeit sowie Anpassbarkeit an verschiedene Nutzungsprofile und Gebäude Bedingung. Bestehende und bewährte Prozesse und Systematiken sollen in die neue Methodik integriert werden. Ebenso sollen aktuelle Gliederungen und Daten, in der Schweiz von der CRB (Zentralstelle für Baurationalisierung) herausgegeben, verwendet werden.

Die Bedeutung dieses Projektes ist für alle Besitzer eines grösseren Immobilienportfolios sehr gross, da mit dieser Methodik eine genaue Zustandserfassung des Gebäudezustandes vereinfacht und die mittelfristige Budget- und Instandsetzungsplanung ermöglicht wird. Damit kann ein Instandsetzungsstau vermieden werden und die Geldmittel können optimal geplant und eingesetzt werden.

3. VORGEHEN ZUR METHODENENTWICKLUNG

Die Entwicklung der Methodik erfolgte einerseits im Rahmen eines Projektes mit einem grossen Schweizer Spital, welches über eine sehr heterogene und alte Gebäudestruktur verfügt. Andererseits basiert die Methodik auf langjährigen Erfahrungen zum Thema Instandsetzung von Gebäuden.

Im ersten Schritt wurden die Literatur durchgesehen und die auf dem Markt verfügbaren Werkzeuge zur Instandsetzungsplanung geprüft. Dazu dienten auch studentische Arbeiten, die am Institut für Facility Management (IFM) der ZHAW durchgeführt wurden. Es zeigte sich, dass es bisher keine Methodik gibt, welche für die hier geschilderte Problemstellung eine Lösung bietet.

Im zweiten Schritt wurden Interviews mit Experten und mit von der Problematik betroffenen Praktikern geführt. Dabei kristallisierte sich als wesentliches Problem heraus, den Zustand der Gebäude und ihrer Elemente genügend genau und detailliert zu kennen. Dieser Inspektionsaufwand ist gross und die Genauigkeit oft ungenügend. Die Folge ist eine ungenügende Planbarkeit der Instandsetzungsmassnahmen. Die neue Methodik soll deswegen diesen Inspektionsaufwand minimieren. Zudem zeigte es sich, dass Instandsetzungsmassnahmen oft spontan aufgrund dringender Verbesserungsbedarfe ausgeführt werden, und sich deswegen zu viele kleine Projekte ergeben. Dies führt zu hohen Kosten für Projektemanagement und Bauausführung. Ein Multiprojektmanagement mit der Nutzung von Synergien und der Bildung von grösseren Massnahmenpaketen ist in der Praxis meist nicht möglich.

Als nächster Schritt wurde die Methodik, basierend auf bisherigen Methoden, entwickelt und dann auf Anwendbarkeit geprüft. Es wurde eine Excel-Datei programmiert, um an Einzelgebäuden die Methodik anwenden zu können. Ein grösseres, altes Spitalgebäude wurde als repräsentativer Fall gewählt. Es zeigte sich, dass die Methodik einfach, mit wenig Aufwand und mit guten Resultaten anwendbar ist.

Zuletzt wurde mit Informatik-Spezialisten und einem CAFM-Anbieter geprüft, ob die Methodik in CAFM-Programmen umsetzbar ist. Auch hier war das Ergebnis positiv. Die Umsetzung in eine kommerzielle Software ist nun der nächste Schritt.

4. DIE NEUE METHODIK FÜR EINE OPTIMIERTE INSTANDSETZUNGSPLANUNG

4.1. EINORDNUNG IN DEN GESAMTPROZESS

In einer ersten Phase ging es darum, die Prozesse der Instandhaltung und Instandsetzung einzuordnen. Dazu wurde das neue St. Galler Managementmodell verwendet. Grundsätzlich gehören die Prozesse der Instandhaltung und Instandsetzung zu den Unterstützungsprozessen (in Abbildung 1 hervorgehoben). Die Unterstützungsprozesse beinhalten sämtliche Tätigkeiten der Bereitstellung von Infrastruktur sowie die internen Dienstleistungen, welche notwendig sind damit die Geschäftsprozesse vollzogen werden können (vgl. (Rüegg-Stürm, 2002)).

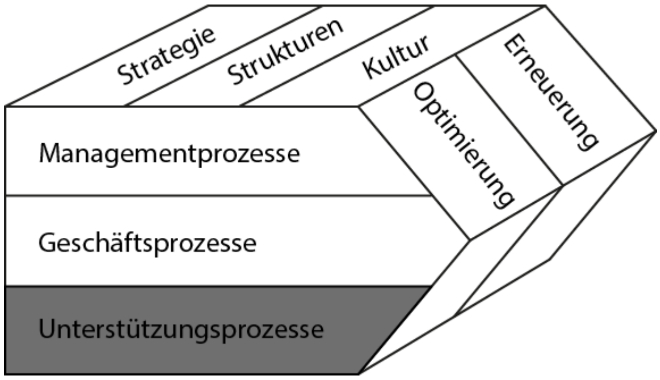

Abbildung 1: Kernelemente des neuen St. Galler Management-Modell (Rüegg-Stürm, 2002)

Die Unterstützungsprozesse beinhalten nach Rüegg-Stürm (Rüegg-Stürm, 2002) sieben Teilprozesse: Personal- und Bildungsarbeit, Informations- und Risikobewältigung, Kommunikation, Recht sowie Infrastrukturbewirtschaftung. Letzterer, folgend Gebäudemanagement genannt, beinhaltet die Aufgaben der Instandhaltung und Instandsetzung. Dabei kann die Instandhaltung als kontinuierlicher Prozess ohne definiertes Ende angesehen werden (Kuster [et al.], 2006). Die Instandsetzung ist langfristig gesehen ebenfalls ein Prozess. Die einzelnen Instandsetzungen allerdings sind als Projekte abzuwickeln, da sie die typischen Projektmerkmale aufweisen. Dazu gehören die Einmaligkeit, die technische und organisatorische Komplexität, die interdisziplinäre Zusammenarbeit sowie die klare Abgrenzung zu den restlichen Vorhaben (Thommen, 2008). Geleitet wird beides in der Regel vom technischen Dienst, der heute zum Facility Management gezählt wird (EN 15221-1, 2006).

4.2. GLIEDERUNG DER METHODIK

Basierend auf den Resultaten und Erfahrungen aus IP-Bau (IP-Bau, Bundesamt für Konjunkturfragen, 1995), Christen et. al. (Christen & Meyer-Meierling, 1999) und DUEGA (Wright-Jungen, 1998) wurde für die neue Methodik eine passende Gliederung gesucht. Damit die Methodik praxistauglich wird, ist es sinnvoll eine aktuelle und zukunftsfähige Gliederung zu verwenden. Die erarbeitete Methodik muss so strukturiert sein, dass man einen stufengerechten Überblick über die Instandsetzungsarbeiten und Kosten erlangen kann. Gewählt wurde der neue Baukostenplan Hochbau eBKP-H, SN 506 511 (Schweizerische Zentralstelle für Baurationalisierung CRB, 2009). Dieser basiert auf einer sinnvollen Anzahl Elementen und entspricht den Bedürfnissen. Die Methodik nach DUEGA arbeitete mit der EKG (Elementkosten-Gliederung, SN 506 502) (Schweizerische Zentralstelle für Baurationalisierung CRB, 2000). Diese wurde wie der eBKP-H von CRB (Schweizerische Zentralstelle für Baurationalisierung) veröffentlicht und durch letzteren ersetzt. Der eBKP-H hat auch die Norm SN 506 500, Baukostenplan BKP (Schweizerische Zentralstelle für Baurationalisierung CRB, 2001) abgelöst und somit die Gliederung nach Gewerken verworfen. Im Falle von Spitalbauten kann der eBKP-H durch das Handbuch Spitalbau (Schweizerische Zentralstelle für Baurationalisierung CRB, 2012 C) ergänzt werden. Aus diesen Dokumenten können wesentliche Daten zu den Elementen genutzt werden. Eine Gliederung nach Gewerken, wie im BKP und Spitalkostenplan 2003 - SKP (Schweizerische Zentralstelle für Baurationalisierung CRB, 2003), kam für die vorliegende Methodik nicht in Frage. Die Gründe werden in den nachfolgenden Kapiteln erläutert.

4.3. PROZESSABLAUF DER METHODIK

Klar definierte Prozesse bilden die Grundlage einer Umsetzung einer neuen Methodik in einem Unternehmen. Abbildung 2 zeigt die nötigen Prozesse in der Übersicht (vgl. (Rüegg-Stürm, 2002)).

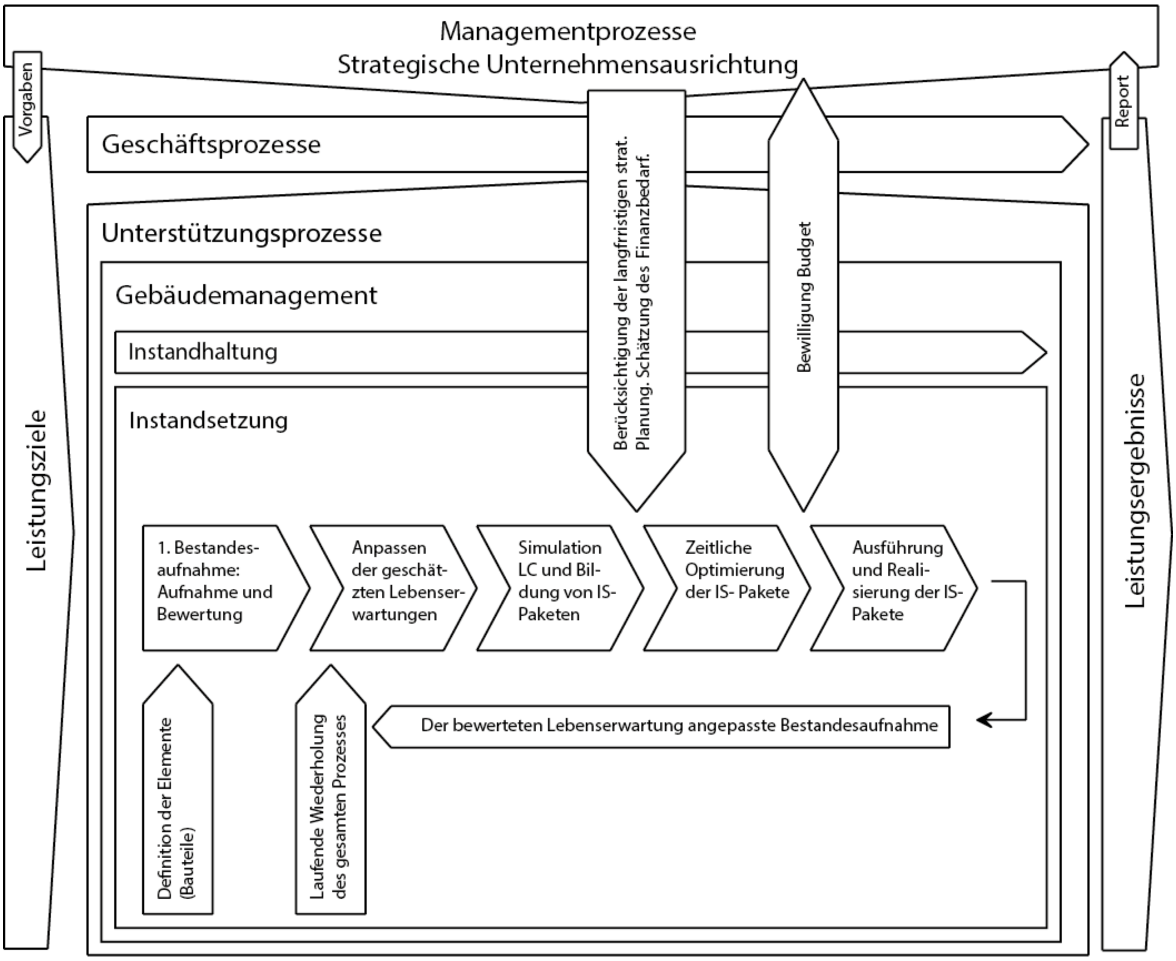

Abbildung 2: Instandsetzungsprozess in der Gesamtprozessübersicht

Die Vorgaben und Leistungsziele können in der Methodik umgesetzt werden, indem die Anforderungen an die Elemente definiert werden. Damit kann der generelle Zustandswert und der Instandsetzungszeitpunkt den Anforderungen angepasst werden.

Um Klarheit in den Begriffen zu haben, und als Übersicht über die relevanten Prozesse, dient die folgende Tabelle 1.

Tabelle 1: Begriffe Instandhaltung und Instandsetzung

Prozesse des Gebäudemanagement	**Beschreibung der Tätigkeit und Problematik**
Instandhaltung	Gemäss DIN (Deutsches Institut für Normung e.V. (DIN), 2012): Kombination aller technischen und administrativen Massnahmen sowie Massnahmen des Managements während des Lebenszyklus einer Betrachtungseinheit zur Erhaltung des funktionsfähigen Zustandes oder Rückführung in diesen, so dass sie die geforderte Funktion erfüllen kann. Instandhaltung (IH) wird hier auch als Überbegriff für Wartung, Inspektion und (kleine) Instandsetzung verstanden. Die Tätigkeiten der Instandhaltung werden laufend ausgeführt und sind für die 4-Jahresplanung nicht weiter von Bedeutung. Sie dürfen aber nicht vernachlässigt werden, da sie für den Erhalt der Gebrauchstauglichkeit ausschlaggebend sind. Unter Umständen können Ergebnisse der Bestandsaufnahme einen Einfluss auf die Tätigkeiten der Instandhaltung haben. Bei einem schlechten Zustand ist ggf. eine Intensivierung der IH-Tätigkeiten erforderlich.
Instandsetzung	Gemäss der DIN bedeutet Instandsetzung (IS): Sämtliche Massnahmen zur Rückführung einer Betrachtungseinheit in den funktionsfähigen Zustand mit Ausnahme von Verbesserungen. Je nach Grösse des Unternehmens, kann es sinnvoll sein die Instandsetzungen zu kategorisieren um die Abläufe zu klären und Kreditvergaben zu beschleunigen. Kleine Instandsetzungen umfassen Reparaturen bis zum Betrag von CHF 50‘000.- und können teilweise direkt bei der periodischen Instandhaltung ausgeführt werden. Bei einem Betrag zwischen CHF 50‘000.- und 1‘000‘000.- kann von mittleren Instandsetzungen gesprochen werden. Darüber kann von grossen Instandsetzungen gesprochen werden. Diese sind zu behandeln wie Neubauten, verlangen eine strategische und langfristige Planung und sind abhängig von der Unternehmensausrichtung.

Die Planung insbesondere der mittleren Instandsetzungen nach der vorliegenden Methodik beinhaltet pro Gebäude die Prozesse nach Tabelle 2.

Tabelle 2: Prozesse im Gebäudemanagement

• ***Definition der Elemente und Zuordnung der Leistungsziele***	Es ist unabdingbar, vorgängig die Elemente zu definieren, welche in der Planung berücksichtigt werden sollen. Jedem definierten Element muss ein entsprechendes Leistungsziel vorgegeben werden. Für ein Spital ist dies von enormer Wichtigkeit, da gewisse Elemente nicht ausfallen dürfen. Dabei ist beispielsweise an die technische Installation in einem OP-Saal zu denken. Diese Zuweisung muss sorgfältig ausgeführt werden, da es bei fehlerhafter Zielbestimmung und dadurch resultierenden falschen Inspektionsintervallen und Instandhaltungsmassnahmen zu inakzeptablen Ausfällen oder erheblichen Mehrkosten kommen kann.
• ***Erste Bestandsaufnahme und Bewertung***	Bei der ersten Bestandsaufnahme müssen alle definierten Elemente erfasst und deren Zustand festgestellt werden. Sollte ein Element in zwei Ausprägungen vorhanden sein, kann dieses in zwei Elemente aufgeteilt werden. Aufgenommen werden, neben dem baulichen und technischen Zustand, jeweils das Alter, sprich das Baujahr des Elementes und seine Bezugsgrösse. Diese Daten sind für eine Eruierung des relativen Alters des Elements und der Instandsetzungskosten nötig. Das relative Alter und der Zustand geben dann wiederum den nächsten Inspektionszeitpunkt für ein Element vor. Zudem wird der theoretisch optimale Instandsetzungszeitpunkt berechnet. Die Bestandsaufnahme muss sorgfältig und vollständig durchgeführt werden. Die Schwierigkeit dabei ist die Bestimmung des Zustands, da dieser meist schwer messbar ist und somit oft auf einer subjektiven Beurteilung beruht. Um eine möglichst hohe Objektivität zu erreichen wurde eine 10-teilige Beurteilungsskala erstellt, nach welcher sämtliche Elemente systematisch beurteilt werden (Abbildung 3).
• ***Simulation des Lebenszyklus***	Mit den gesammelten Daten und den Randbedingungen aus den Leistungszielen kann das relative Alter aller Elemente berechnet werden. Damit können, wie bereits erwähnt, die nächste Inspektion und der optimale Instandsetzungszeitpunkt jedes Elementes bestimmt werden. Insgesamt kann damit der nächste Abschnitt des Lebenszyklus des Gebäudes vorausberechnet werden.

• ***Bildung von IS-Paketen und deren zeitliche Optimierung***	Diese Instandsetzungs-Zeitpunkte müssen nun so angepasst werden, dass sie einerseits bautechnisch und betrieblich sinnvoll abgewickelt und andererseits auch finanziert werden können. Diese Anpassungen führen zu IS-Paketen. Die Bildung der IS-Pakete erfolgt ca. 3 bis 4 Jahre vor Umsetzung, 2 Jahre vor Umsetzung werden die IS-Pakete bewilligt und ein Jahr vor der Umsetzung erfolgt die Planung der Massnahmen. Dieser Ablauf kann aber je nach Projektgrösse variieren. Weiteren Einfluss auf diesen Prozess haben einerseits die strategische Ausrichtung der Unternehmung, andererseits die Finanzplanung.
• ***Ausführung der IS-Pakete***	Nach der vollständigen Planung der IS-Pakete, z.B. nach SIA 112 (Schweizer Ingenieur- und Architekten- Verein (SIA), 2001), müssen die Massnahmen umgesetzt werden. Die erforderlichen Budgets werden aufgrund der Kostenvoranschläge jeweils ca. im Sommer aufgestellt und dann im September bewilligt. Im Folgejahr können die Massnahmen in der Regel ausgeführt werden.
• ***Laufende Bestandsaufnahme***	Nach der Erstaufnahme oder bei neueren Bauteilen müssen die Inspektionen laufend gemäss der Festlegung der optimalen Inspektionszeitpunkte durchgeführt werden.
• ***Ausserplanmässige Anpassungen***	Es ist durchaus möglich, dass ein Element nicht planmässig altert und somit zu einem früheren oder späteren Zeitpunkt instandgesetzt werden muss. Zudem können auch Änderungen von Richtlinien oder Gesetzen dazu führen, dass ein Element früher als geplant instandgesetzt werden muss. Dies würde eine Änderung der Randbedingungen resp. Leistungsziele des Elements bedeuten(erster Prozessschritt), was ebenfalls eine Aktualisierung im System nach sich zieht.

Für die Bewertung der einzelnen Elemente wurde die Bewertungsskala gem. Abbildung 3 entwickelt. Diese unterscheidet sich von bisherigen Skalen durch eine detailliertere Abstufung und eine klare Bezeichnung der einzelnen Zustandswerte. In der Probeanwendung durch vier unterschiedlich ausgebildete Personen zeigte es sich, dass sich damit eine personen-unabhängige, genaue Zustandsbewertung erzielen lässt. Die Standardabweichung der Zustandswerte betrug knapp 0,05 bei 62 bewerteten Bauteilen. Der Zeitaufwand für die Erfassung dieser Bauteile in einem grösseren Spitalgebäude dauerte einen Arbeitstag. Damit konnte das ganze Gebäude sehr genau bewertet werden.

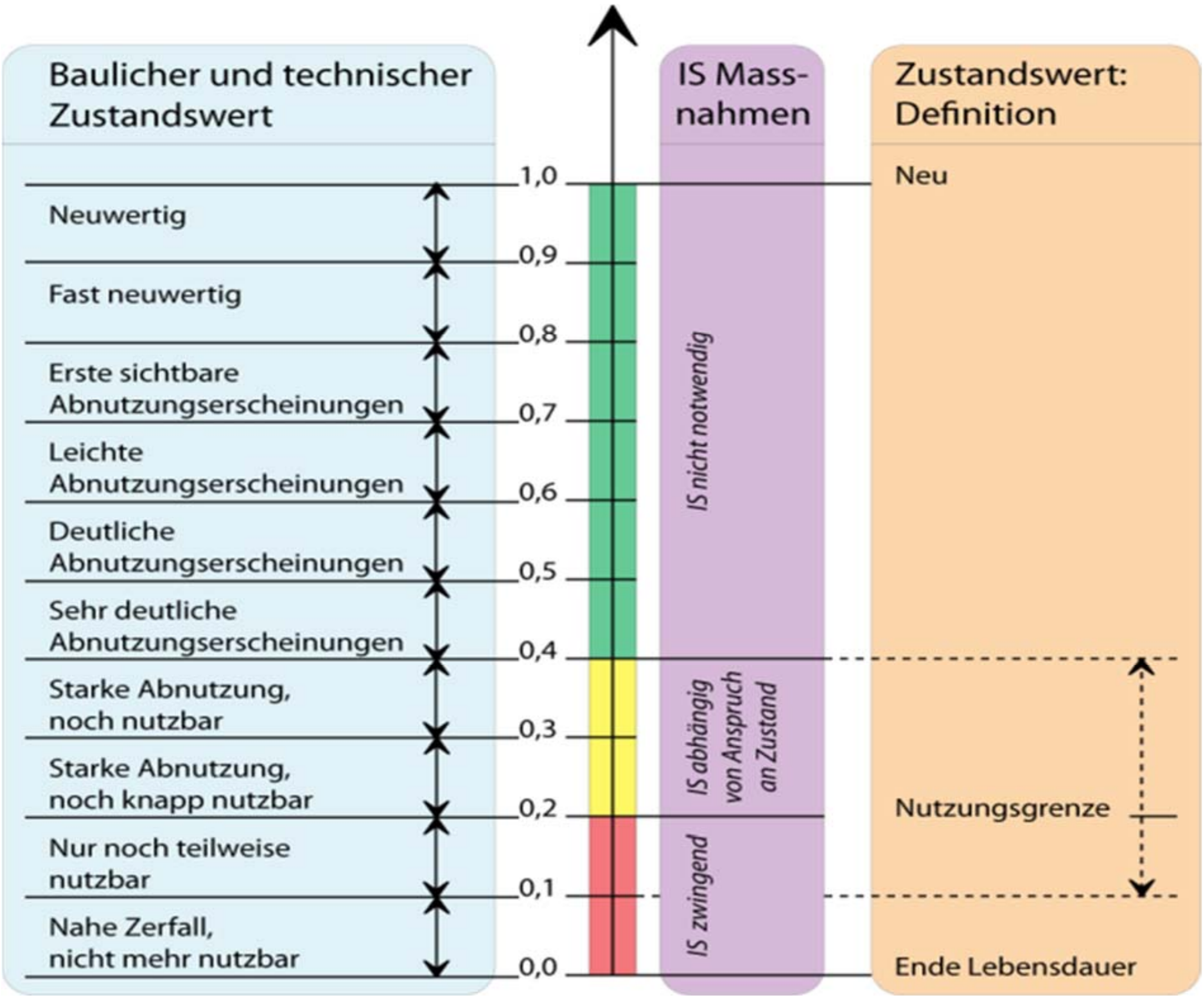

Abbildung 3: Beurteilungsskala Elemente

4.4. DYNAMISCHE ZUSTANDSAUFNAHME

Das reale Alterungsverhalten kann teilweise stark vom theoretischen Lebenszyklus einzelner Elemente abweichen, sind Zustandsaufnahmen notwendig. Periodische Bewertungen führen zu einem beträchtlichen Aufwand. Dieser kann mit der Bestimmung von dynamischen Inspektions-Zeitpunkten minimiert werden. Diese Methode erlaubt es, für jedes Element eines Gebäudes mit einer initialen und einer bis zwei weiteren Bewertungen den optimalen Zeitpunkt der Instandsetzung festzulegen. Als Grundlage wird die theoretische Lebensdauer für jedes Element benötigt. Diese Daten kann man beispielsweise der dreiteiligen Publikation zu Lebenszykluskosten von CRB entnehmen (Schweizerische Zentralstelle für Baurationalisierung CRB, 2012 B), (Schweizerische Zentralstelle für Baurationalisierung CRB, 2012 D), (Schweizerische Zentralstelle für Baurationalisierung CRB, 2012 A). Diese gibt minimale, mittlere und maximale Lebenserwartungen verschiedener Elemente an. Anhand eines Praxisvergleichs dieser Werte, den Studien aus IP-Bau (IP-Bau, Bundesamt für Konjunkturfragen, 1995) und der Forschungsarbeit von Christen et. al. (Christen & Meyer-

Meierling, 1999) wurde deutlich, dass eine lineare Alterung, wie sie in der Anlagebuchhaltung verwendet wird, nicht realistisch ist. So wurde eine progressive Alterung der Elemente entwickelt. Bis zu einem Zustandswert von 0,4 (vgl. Abbildung 3) ist die Alterung linear. Wenn der Zustandswert unter die Grenze von 0,4 fällt, wird die Abnahme progressiv. Dies bedeutet, dass die Alterung schneller voranschreitet je näher ein Element an sein Lebensende kommt.

Zur Bestimmung des idealen, das heisst spät möglichsten Inspektionszeitpunktes werden grundsätzlich zwei Ansätze angewendet, je nachdem ob das Bau- oder Installationsjahr eines Elementes bekannt ist (Ansatz 1) oder nicht (Ansatz 2). Der spätmöglichste Inspektionszeitpunkt wird so gewählt, dass sicher alle Bauteile vor Ende der Lebensdauer inspiziert werden und noch genügend Zeit für die Planung des Bauteilersatzes bleibt. Andererseits kann dann die Restlebensdauer besonders genau abgeschätzt werden.

Ansatz 1: Die Kurven der Lebensdauer (vgl. Abbildung 4) werden so gelegt, dass sie alle bei $t = 0$ einen Zustandswert von 1 aufweisen. Die Abszisse ist dabei als absoluter oder relativer Zeitstrahl in Jahren zu verstehen. Das Element wird bei der initialen Bewertung inspiziert, die 5 Jahre vor der minimalen Lebenserwartung erfolgt. Der effektive Zustand wird fast immer irgendwo zwischen dem minimalen und maximalen Zustandswert liegen. Mit dem Anfangspunkt und der Bewertung kann nun die effektive Lebensdauerkurve gezeichnet werden. Die Nutzungsgrenze (zwischen Zustandswert 0,1 und 0,4) wird aufgrund der Anforderungen an das Element festgelegt. Der Zeitpunkt der optimalen Instandsetzung wird erreicht sobald der Zustandswert unter die so festgelegte Nutzungsgrenze fällt. Der nächste Inspektionszeitpunkt ist 5 Jahre vor dem vorausberechneten Instandsetzungszeitpunkt. Bei dieser zweiten Bewertung wird allenfalls die Kurve des Alterungsverhaltens erneut angepasst und der korrigierte Instandsetzungszeitpunkt oder ev. ein dritter Inspektionszeitpunkt festgelegt.

Ansatz 2: Dieser zweite Ansatz kommt zur Anwendung wenn es nicht möglich ist das Baujahr oder die letzte Instandsetzung genau zu datieren. Die beiden Kurven (*L min, L max*) (vgl. Abbildung 5) werden so gezeichnet, dass beide auf dem aktuellen Bewertungszustand liegen. Dies ergibt eine theoretische Kurvenschar für die Vergangenheit und eine Kurvenschar für die Zukunft. Diese kann nun, falls Schätzungen zum Elementalter vorhanden sind, eingeschränkt werden (Abbildung 5: grauer Bereich), was die Prognose verbessert. Anschliessend ist das Vorgehen analog zu jenem des Ansatzes 1. Die effektive Lebensdauerkurve in Abbildung 5 kann erst nach der zweiten Inspektion eindeutig definiert werden. Aus diesem Grund wird der Instandsetzungszeitpunkt konservativ gewählt, was eine etwas verfrühte zweite Inspektion nach sich zieht, wodurch eher eine dritte Inspektion nötig wird.

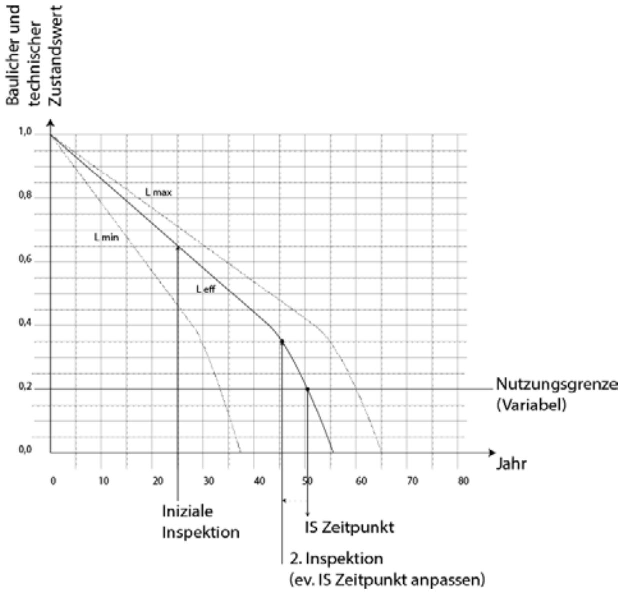

Abbildung 4. Ansatz 1, bekanntes Baujahr

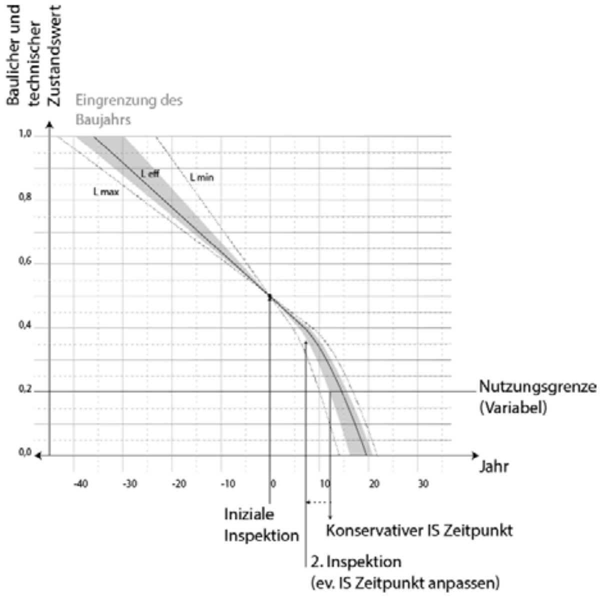

Abbildung 5: Ansatz 2, unbekanntes Baujahr

5. DISKUSSION

Die entwickelte Methodik mit der dynamischen Zustandsaufnahme eignet sich für jegliche Immobilien. Der Zustand auch von grossen Gebäuden und ganzen Portfolios kann mit minimalem Aufwand und trotzdem mit hoher Genauigkeit erfolgen. Durch die Wahl der Gliederung (z.B. nach eBKP-H) kann die Methodik den Bedürfnissen der Anwender angepasst werden. Die einzelnen Elemente können in Elementgruppen oder Hauptgruppen zusammengefasst werden (Schweizerische Zentralstelle für Baurationalisierung CRB, 2009). So können stufengerechte Aussagen über den Gebäude-Zustand gemacht werden. Neben der rein technischen Notwendigkeit, ein Element instand zu halten, spielen die finanziellen Ressourcen eine ebenso wichtige Rolle. Das Kostenoptimum der Instandsetzungen kann mit Hilfe der individuellen Leistungsziele und der Bildung von Instandsetzungspaketen gefunden werden. Die Methodik eignet sich somit auch ideal zur Budgetplanung. Dabei folgt sie nicht einer linearen buchhalterischen Abschreibung, sondern verwendet den effektiven Zustand der Elemente in der Berechnung. Der effektive Finanzbedarf kann so über mehrere Jahre mit einem hohen Genauigkeitsgrad prognostiziert und budgetiert werden.

Die grösste Herausforderung wird es sein, die bestehende Datenbasis von CRB bezüglich Kostenkennwerte zu erweitern. Im Idealfall werden die Daten verschiedener Anwender anonym der Allgemeinheit zur Verfügung gestellt, was ein Benchmarking ermöglichen würde. Vor allem für Gebäude, welche nicht als Wohnhäuser genutzt werden, gibt es in der Schweiz zurzeit noch wenige Daten. Es ist jedoch möglich auf Daten aus Deutschland auszuweichen und mit diesen zu arbeiten (BKI Baukosteninformationszentrum, 2013 A) (BKI Baukosteninformationszentrum, 2013 B). Im Pilotprojekt wurden damit gute Erfahrungen gemacht. Dadurch können die Kosten der Instandsetzungen recht genau vorhergesagt werden, was die Budgetplanung erheblich verbessert.

Für die Akzeptanz und Praxistauglichkeit muss die Methode mit einer professionellen Softwarelösung unterstützt werden, an der zurzeit gearbeitet wird. Erst der Einsatz der Methode wird zeigen, welche Ergebnisse damit erreicht werden und wie gross der Spareffekt wird.

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Wissenschaft trifft Praxis II:

Gebäudebewertung und Green Buildings

Incorporating Green Building Features into Property Valuation Practices

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Abstract

The aim of this paper is to review the relationship between sustainability and property value in commercial real estate and provide some suggestions for valuers in recognising the sustainability features as part of property evaluation process. In doing so, the key factors that impact the valuation of commercial property are identified. The survey of stakeholders in Singapore's real estate industry was also conducted. The findings indicate that the stakeholders generally recognise the importance of sustainability but with a strong focus on economic factors such as lower costs and asset financial performance. Though social benefits are recognised, their translation into financial value is more complex. Further quantitative and market studies are required to evidence the link between sustainable characteristics of buildings and their property value. Some guidelines have been proposed as a result of this study and they include improving data collection and storage, enhancement of the current valuation parameters to incorporate financial benefits of sustainability features as well as the need for continual learning and development in the area of sustainability.

Keywords: green buildings, property valuation, real estate

1. Introduction

Contributing up to 40% of CO_2 emissions, 40% of energy consumption, 16% of water usage, 30% of solid landfill waste and 40% of raw materials consumption [16], buildings have a major impact on climate change. One key justification to encourage action within the property and construction sector is its greatest potential to contribute toward carbon emission reductions, [17]. The public sector, industry and non-profit organisations have strived to encourage the adoption of sustainability practices for implementation in the built environment through various means. Changes in policy and regulations within the real estate industry are continually being introduced; more so in developed markets globally: forms of mandatory policies, such as the requirement for buildings in the European Union (EU) to publicly display Energy Performance Certificates and other market-based environmental rating and certification systems for buildings such as LEED (USA), Energy Star (USA), Green Star

(Australia), BREEAM (UK) and Green Mark Scheme (Singapore), [29]. Some progress has been made in areas of planning, design, construction techniques, building products and materials, rating and assessment tools. However, in practice some argue that these broadly technocratic approaches had insignificant impact on property markets, [12]. The stakeholders, i.e. owners and occupiers, are usually more interested in the financial benefits of sustainability initiatives, [27]. Which is why, professionals in the industry, especially valuers, have a key role to play in assessing and advising about the effect of sustainability on property value. Without financial justification the viability of the required investment in commercial real estate may not be fully recognised and the advancement of sustainability may be limited. In the operation of commercial markets, price signals are central in providing information for the basis of allocation of resources. In a real estate context, higher potential returns on certified green buildings would not only increase the development, supply and use of such buildings but also encourage greater investment in this area. The value of property investments in Singapore averaged US$24billion annually for the last 3 years representing about 9.7% of annual gross domestic product, [6, 24]. With a target of at least 80% of buildings in Singapore achieving the Green Mark (GM) certification by 2030, [2], benchmarking green buildings features against the value of property will certainly influence investments in green buildings.

The main objective of property valuation is to provide a financial measure of the function or service derived from the use and control of property. Value is determined through the flow of services it is capable to generate to meet the requirements of owners and/or occupiers. Depending on the purpose of the valuation, concepts of value used in property valuation can either be market value (i.e. exchange value) or worth (i.e. use value), [19]. Worth can be defined as the value of the property to a particular investor, mainly for the purpose of investment. Market value is shaped by competitive forces within the market where the property is located identifying what is likely to be the highest and best offer in exchange of the asset. The Singapore Institute of Surveyors and Valuers (SISV) adopts Valuation Standards and Guidelines that members have to follow. Non-SISV members abide by the valuation standards and guidelines issued by the Royal Institution of Chartered Surveyors (RICS) and/or the International Valuation Standards Committee. The SISV Standards generally adopts the International Valuation Standards based on three fundamental approaches: Direct Comparison Method (inferring value by comparing properties to similar buildings); Cost Method (takes into consideration initial costs) and Income Method (estimates net income that the property may generate in the form of a direct capitalisation method or a discounted cash flow over an appropriate period), [25].

A study done by RICS in the UK in 2005 concluded that; not only are green buildings good for the environment, provide healthier places to live and more productive places to work, they can command higher rents and prices, attract tenants more quickly, reduce tenant turnover and cost less to operate and maintain, [20]. Though financial benefits and risks reduction of sustainable buildings may be acknowledged, (i.e., by banks, insurance agencies, investors, occupiers etc.), there is no hard data to support this. Also few green buildings have yet to change hands, or are within private ownership. When valuers compare prices they need to consider that the final price of the transacted asset may be brought about by the interplay of constellations of price-determining factors, [11]. These exchange ratios are not constant and typically valuers make their own informed judgments on the assessment of market value of property. In practice, there are no clear approaches yet, for including the value of sustainability when assessing the value of green buildings. Thus, valuers and appraisers need to understand the specific features of green buildings, adopt methods to assess the impact on property value and possibly fine-tune the current methods to address these new issues. The growing push towards green certified buildings has generated greater research on the subject, but quantified research on the relationship of green features to asset value is still in its infancy, [18].

This paper looks at current practices in identifying the value of green buildings, and examines the link between commercial real estate value and features of green buildings with the aim to propose possible approaches that could be adopted by the real estate sector in valuing green buildings, and some guidelines that could be incorporated into property valuation practices. This is done through a review of academic papers, industry publications and a survey conducted with stakeholders within Singapore's real estate industry.

2. The added value and cost of green buildings

To be able to adequately consider the impact of sustainability issues on property values it is necessary to define what a 'green building' is. The expression green building and sustainable building are often used interchangeably, though these terms can have different meanings too. Green buildings can be expected to consume less energy and thus consequently generate lower CO2 emissions. The definition of a sustainable building "goes far beyond the narrower concept of lowering a building's energy consumption", [12, p 60], as sustainable buildings are constructed with a higher urban planning, creative, functional and technical quality. In the context of this paper, the term 'green building' is used for those buildings which have low environmental impact throughout all phases of their life cycle and provide healthy indoor environments, [13].

There is a general consensus that sustainable buildings are more energy efficient; have lower operating and maintenance costs; provide better comfort and well-being for occupants; are more marketable than conventional buildings; have lower risk potential; and reduced negative impact on the environment, [8, 10, 20]. Sustainable commercial buildings also have a competitive advantage over conventional buildings and are able to attract higher profile tenants, command above market rentals and thus increase capital values, [28]. While environmental benchmarking is well advanced within the framework of rating systems like BREEAM and LEED, benchmarks for social factors are not yet established. The studies which included some social factors such as health and safety, compliance with legislation, occupant satisfaction and productivity found that green commercial buildings provide a healthier and more enjoyable working environment and have been shown to improve worker productivity, [10, 12, 22].

Some links are beginning to emerge between market value of a building, its sustainable features and financial performance. The Green Building Council of Australia reported in 2008 that sustainable buildings in Australia commanded 5% to 10% higher rents and had higher relative investment return and asset values of 10%., [8]. A study of 23 refurbished commercial properties in Singapore concluded that retrofitting against GM standards can lead to an increase in the property value of about 2%, with an average expected savings in operating expenses of 10%, [3]. A report published by the RICS in 2005 concluded that a clear "link is beginning to emerge between the market value of a building and its green features and related performance" [19, p 3]. Several studies found a positive effect of the Energy Star certification with some differences in the extent of the relationship, [7, 9, 13]. They all used data from the CoStar database, which utilised sales, and rental transaction data for office property in the US. Using a sample of 550 Energy Star rated buildings and 318 LEED rated buildings, it was found in [13] that the average LEED impact on sales price per square foot is 9.94%, while the Energy Star impact on sale price is 5.76%. The analysis of 10,000 subject and control buildings to identify the economic values of certified green buildings in the US found that Energy Star certification achieved more than 3% rental per with increment selling prices as high as 16%, [7]. The results suggested a premium for Energy Star buildings, but not LEED certified buildings. Another study analysed transaction prices for 292 Energy Star and 30 LEED certified buildings. A 10% price premium was found for Energy Star and 31% price premium for LEED certified buildings as compared to non-certified buildings within the vicinity, [9]. The large variance in these quantitative studies would suggest that the results cannot be considered statistically significant with confidence. Valuers would not be able to utilise the information to accurately assess a relationship between sustainability and market value, as the reliability and communication of the specific quantitative results of these studies are incomplete and inadequate for use in practice, [15]. It's argued in [12] that a major obstacle for a more scientific basis for integration of sustainability aspects into property valuation is due to insufficient property transaction evidence linking the buildings' environmental and social performance to property prices. Studies that investigate the relationship between building characteristics and property prices rely on property transaction databases that contain generally crude statements on the availability, age or size of particular building features and/or by making use of subjective and mainly qualitative judgments based on implicit assumptions. As such benefits of sustainability may be reliant on the knowledge, judgment and experience, or lack thereof, of the individual valuer. In addition, the application of sustainability assessment tools has not yet gained general market acceptance within the property sector.

Research has also been done in proposing to modify valuation theory and methodologies to incorporate sustainability features in valuation, [5, 11, 23]. Generally they proposed that sustainability issues would affect major risk factors in computing the asset value. Thus, valuers can attach a risk premium to each of these factors or group the risk factors to adjust other parameters used in traditional valuation methods. The proposed model for a sustainability appraisal in [23] assumes that all the characteristics of a property investment can be reflected through four key variables: rental growth, depreciation, risk premium and cash flow. It is further assumed that the specific sustainability criteria (building adaptability, accessibility, building quality, energy efficiency, pollutants, waste and water, occupier satisfaction) would impact on one or more of these key variables. In order for the additional construction costs of green buildings to be rationalised, investors would require a combination of higher income and/or reduced risks. Failure to recognise price premiums at the initial phase would be a disincentive for stakeholders to invest in green buildings. Such costs therefore would have to be accompanied by an understanding of benefits obtained for the additional construction costs to be justified. Several studies found that initial construction costs are typically higher but these extra costs may be recouped through operating savings and reduced energy costs, [20, 21, 26].

In summary, green buildings have characteristics and benefits that could influence value not only from environmental efficiency, but also improved health and productivity, a competitive advantage and increased marketability over conventional buildings. Certified buildings have a positive effect on property rental and values. Whilst there is a construction cost premium involved, they have lower operating costs over useful life. The existing studies have also attempted to quantify the financial costs and benefits to provide some certainty around the relationship between sustainability and property value. However, in reality, the applicability of these studies is not appropriate for the valuation profession. To develop an opinion on value, an appraiser investigates how the market views a particular property, which will require an analysis of trends and forces that influence value but will also rely on appraiser's expert intuition. Valuers may also not have a full understanding of the characteristics or ability to translate these into financial benefits to form appropriate assessments on property value. Generally few of the studies have been able to propose suitable methods to identify a relationship between sustainability and property value or propose guidelines on how this could be done in practice.

3. Research Design

For this study, rather than trying to draw some conclusion from the limited number of available empirical studies, it was decided to carry out a targeted questionnaire type survey. The questionnaire was distributed to a group of stakeholders who are involved in various aspects of the property and real estate sector in Singapore: developers, investors, financiers, valuers, consultants and asset and facility managers. The main aim of the survey is to gather and review their perception of the economic, social and environmental impact of green buildings on property values. The survey comprises of an electronic questionnaire based on a standard set of questions to obtain mainly qualitative responses. The electronic survey was conducted over a 3-week period from 19th July to 9th August 2013. The questions addressed 3 areas (Section 1-3), with an additional comment field under Section 4.

Section 1: *What aspects do you think have the greatest potential impact on the market value of Green Buildings*? comprises of 15 questions on the benefits of sustainable buildings. These were grouped into 4 categories Enhanced Value, Maintenance/Cost Savings, Sustainability and Legislation with further breakdown to specific issues as presented in Table 1. Respondents were asked to rank the factors according to the level of importance on a 5-point Likert scale, with 1 being 'Least Important' and 5, 'Most Important' to allow for further evaluation and comparison of the responses for the various categories into positive and negative. A central 'Neutral' rating was also allowed. Section 2: *Do you agree (or disagree) with the following statements on Green Buildings?* requested respondents to indicate their agreement or disagreement of 7 typical statements of sustainable buildings, mainly focusing on economic and social considerations. Responses are also required to be ranked according to a 5-point scale, with 1 being 'Strongly Disagree' and 5 'Strongly Agree'. In Section 3: What do you consider are the most important factors in evaluating or assessing the market value of a commercial Green Building? the respondents were asked to list down not more than 8 key factors that should be considered in evaluating the market value of Green Buildings, based on typical factors currently adopted by valuers, [25], such as location, size, age, etc. Section 4 offered the possibilities to the respondents to include any other remarks on the financial benefits of green buildings from their individual perspective. Section 5 of the survey was designed to establish a Demographic profile which included profession and length of service.

Tab 1: Aspects which Impact Market Value, (Kats *et al*., 2003, Fuerst and McAllister, 2007 and GBCA, 2008)

Enhanced Value	**Maintenance Costs**	**Sustainability**	**Legislation**
Better market positioning	Lower operating cost	Reduced impact on the environment	Compliance with legislation
Able to command higher quality tenant	More energy efficient	Meeting CSR initiatives	
Atracts good quality tenants	Reduced need for future refurbishment	Reduced health and safety issues	
Faster take-up rate	Lower service charge	Increased productivity	
Lower tenant turnover	Reduced liability, risks		
Higher demand from investors			

4. Results and Analysis

A total of 41 completed survey forms were returned. Of the total number, about 40% of respondents are current practitioners in asset, property and or facilities management. Another 15% are consultants involved in various building related aspects including design and environmental management. 12% are involved in finance and real estate investments, 7% property development and 2% valuation; overall a fair mix of participants presently involved in the property and real estate industry. 56% of the respondents have been working in their current capacities for more than 11 years of which 9 respondents have at least 20 years of service. More than 80% of the respondents have a minimum degree qualification, 11 of whom hold a Masters or PHD. Respondents were required to answer all questions for each of the four categories under Section 1. The responses regarding Enhanced Value are presented in Table 2. A total of 62.2%, of responses rated these aspects to be important or most important (54.10% + 8.10%) i.e. having a positive influence on property market value. The 3 highest ranked attributes, better market positioning, ability to attract good quality tenants and command higher rental show a focus on income generation. 1 respondent felt that none of these 6 aspects had the potential to impact on the market value of green buildings.

Tab. 2: Section 1; Aspects - Enhanced Value

What aspects do you think have the greatest potential impact on the market value of Green Buildings?						
Aspects	Least Important	Not so Important	Neutral	Important	Most Important	Total Responses
i. Better market positioning	1	7	3	25	5	41
ii. Commands higher rental	1	3	4	28	5	41
iii. Attracts high profile tenants	1	7	4	23	6	41
iv. Faster take-up rate	1	10	11	19	0	41
v. Lower tenant turnover	1	13	11	16	0	41
vi. Higher demand from investors	1	7	7	22	4	41
Enhanced Value (Total for 6 Aspects)	**6/2.4%**	**47/19.1%**	**40/ 16.3%**	**133/ 54.10%**	**20/8.1%**	**100%**

The responses related to Maintenance Costs (lower operating costs, more energy efficient, reduced need for future refurbishment, lower service charge and reduced risks) are presented in Table 3. 37 out of 41 (90.2%) respondents rated lower operating costs as important or most important and only 1 respondent rated energy efficiency as least important. Reduced need for future refurbishment and lower service charge were rated almost equally with about 44% of respondents who felt that these aspects were not important or took a neutral stand on the position. About 68% rated reduced liability and risk as import or most important. Overall, about 73.7% (56.60% + 17.10%) rated these 5 aspects important or most important in influencing the market value of property.

Tab 3: Section 1; Aspects - Maintenance Costs / Savings

What aspects do you think have the greatest potential impact on the market value of Green Buildings?						
Aspects	Least Important	Not so Important	Neutral	Important	Most Important	Total Responses
i. Better market positioning	1	7	3	25	5	41
ii. Commands higher rental	1	3	4	28	5	41
iii. Attracts high profile tenants	1	7	4	23	6	41
iv. Faster take-up rate	1	10	11	19	0	41
v. Lower tenant turnover	1	13	11	16	0	41
vi. Higher demand from investors	1	7	7	22	4	41
Enhanced Value (Total for 6 Aspects)	**6/2.4%**	**47/19.1%**	**40/ 16.3%**	**133/ 54.10%**	**20/8.1%**	**100%**

The responses in relation to a third category from Section 1 about different sustainability aspects are presented in Table 4. The responses indicate mainly positive attitudes with 71.3% (57.30% + 14.0%) indicating that environmental and social attributes play an important role in contributing to the market value of property. Compliance with legislation weighted heavily on the positive side with 90.30% ranking this factor to be important or most important (53.70%+36.60%). Again, 1 respondent felt that this aspect was least important.

Tab 4: Section 1: Aspects – Sustainability

What aspects do you think have the greatest potential impact on the market value of Green Buildings?						
Aspects	Least Important	Not so Important	Neutral	Important	Most Important	Total Responses
i. Reduced impact on the environment	1	1	1	29	9	41
ii. Meeting corporate social responsibility initiatives	1	7	3	24	6	41
iii. Reduced health and safety risks	1	5	5	24	6	41
iv. Increased occupant productivity	3	10	9	17	2	41
Sustainability (Total for 4 Aspects)	**6/3.7%**	**23/14%**	**18/11%**	**94/ 57.3%**	**23/14%**	**100%**

In summary, it can be said that of all the 4 aspects (enhanced value, maintenance cost, sustainability, legislation) which where the topics of Section 1 of the survey, greater importance is placed on legislation and maintenance costs as compared the sustainability and enhanced value categories.

As part of Section 2, respondents were requested to indicate their agreement or disagreement with 6 typical statements about green buildings covering initial capital outlays, investment and operating performance, maintenance and operations and competitive advantage as presented in Figure 1.

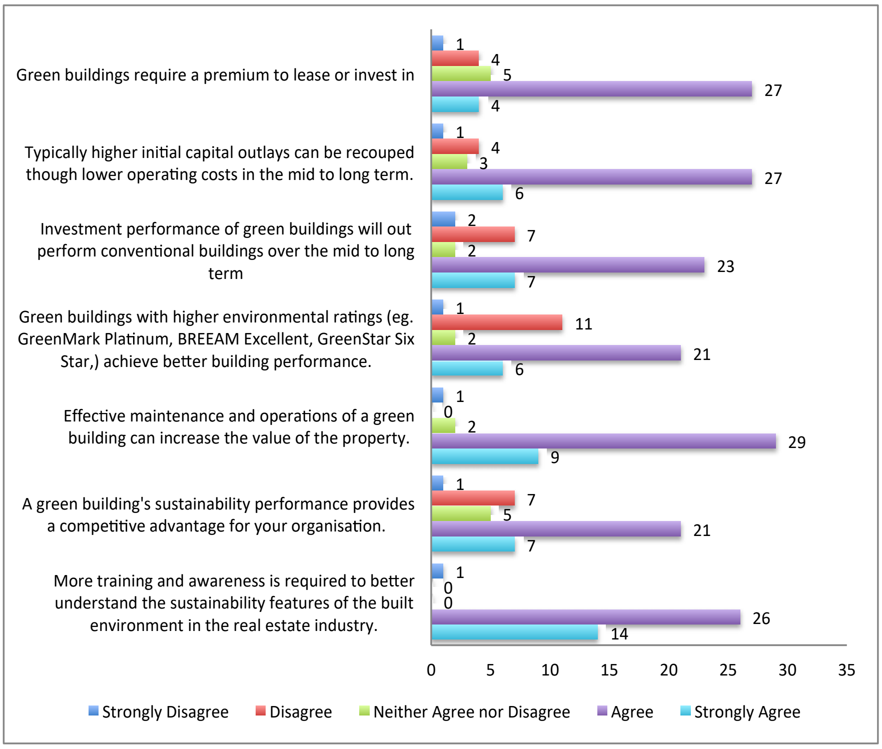

Fig 1: Statements on Green Buildings

A final question was also included to see if more training and awareness is required. Overall 75% of responses agree/strongly agree that green buildings require a premium either to lease or invest in. However 80% also agree/strongly agree that the higher initial outlay can be recouped over the mid- to long-term through lower operating costs. 22% disagree/strongly disagree that investment performance of green buildings would out perform conventional buildings over the mid to long term. Whether these factors weigh positively, depends on the value driver of the stakeholder. For developers who intend to dispose off their building stock quickly, the longer recovery period may not be viewed favourably. 65% of responses agree/strongly agree that buildings with higher certifications achieve better operational performance. Over 92% feel that effective maintenance and operations of a green building can increase its value. Competitive advantage was not a key factor with about 42% either disagreeing or remained neutral on the benefit of this intangible benefit. Lastly, only 1 respondent strongly disagrees that more training and awareness is required within the real estate industry to understand issues of sustainability in the built environment. The 8 factors considered most important when assessing the value of a commercial green building were not much different from the assessment criteria presently used by valuers (Fig 2). Location ranked the highest with 39 out of 41 responses followed by condition (32), operating cost (31) and design/features (30). Tenure, age and size gathered almost similar responses. It is interesting to note is that 26 responses indicated sustainability features.

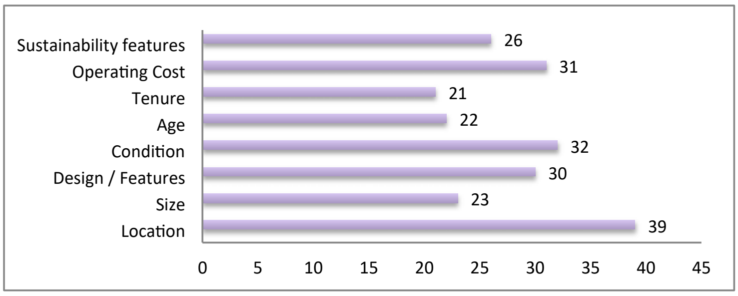

Fig 1: Factors in Assessing the Value of Green Commercial Buildings

The survey registered an overall response of 75% who agree/strongly agree that green buildings require a cost premium either to lease or invest in. Factors that reduce environmental impact such as energy efficiency, lower operating costs and effective maintenance and operations are ranked favourably in their impact on property value. 65% of the respondents also agree that green buildings with higher certifications achieve better performance. The survey respondents also ranked market positioning, ability to attract good quality tenants and command higher rental, as important factors. However whether one would pay the additional 'premium' for such benefits has not been evaluated. The results seem to identify a distinct link between benefits of green buildings and property value for commercial real estate, mainly focused on economic factors (i.e. higher initial capital outlays, ability to recover costs and generate better rentals). A further in depth and quantitative study should be carried out at a later stage to show evidence of this financial impact.

4.1 Proposed Guidelines

Three main areas identified as fundamental in enabling valuers to take into account green building features are proposed. The first is data collection. This is an important part of the valuation exercise and it is proposed that valuers expand their data collection to include key sustainability features that could impact on property value. This could relate to building performance, ratings and certifications, health and safety records, CSR initiatives etc. currently not requested as part of the due diligence by valuers. The valuation report should also reflect this information. The challenge is having a central repository for such data and to ensure that data captured is consistent and comparable. The second is linking key sustainability features to factors currently adopted by valuers in property valuation as presented in Table 5. The objective is to encourage valuers to identify the financial benefits of these enhanced features and incorporate them within the aspects currently being assessed, without changing the principle basis of current valuation practice. The perspective of different stakeholders will also have to be taken into consideration as investors would generally look at economic returns and owners and occupiers may focus on environmental and social factors such as health and wellbeing. The third is the provision for continual learning and understanding of sustainability features, and developments in the area such as policies, incentives, design strategies, technologies etc. Closer co-operation is also required among the regulators of the built environment, stakeholders in the real estate industry, professional bodies and valuers for better exchange of knowledge, i.e. by conducting joint discussions when policies and incentives are introduced by regulators and accredited courses by professional bodies (i.e. SISV) to improve the understanding of sustainable buildings and their economic and environmental performance.

Tab 5: Linking sustainability features which can impact valuation factors

Sustainability features	Factors currently assessed by Valuers to be enhanced	Impact on Property Value due to
Better market positioning, attracts better tenants	• **Location** (Income Method) (Direct Comparison)	Increased accessibility, reduced environmental impact
Health and well-being, Increased productivity	• **Design/Features** (Cost Method)	Increased comfort and well-being of occupants
Maintenance costs savings, energy efficiency, water efficiency	• **Operating costs** (Income Method)	Lower operating costs, higher net income
Effective maintenance and operations	• **Age / Condition** (Income Method)	Lower operating costs, higher net income
Refurbishment to comply with building codes, legislation	• Age / Condition (Cost Method)	Higher initial capital costs
Reduced impact on the environment. e.g. Sustainable renovation guidelines to be stipulated in the tenancy agreements.	• **Tenure** (Income Method)	Better Sustainability performance provides competitive advantage
Corporate Social Responsibility Initiatives	• **Sustainability features** (Income Method)	Higher demand from tenants, increase financial performance
Compliance with legislation, reduced liability and risks	• **Risks** (Income Method)	Lower risks and insurance premiums

5. Conclusion

Green buildings generate benefits not only from environmental efficiency, and a positive effect on property rental and values but also improved health and productivity, a competitive advantage and increased marketability over conventional buildings. Though benefits exist, the ability to quantify and assess a relationship between sustainability and property value is more difficult, whether through adopting cost-benefit analysis or quantitative evaluations. For sustainability to be assessed not only should a relationship between sustainability and market value be identified, but improved valuation tools and methodologies are required. The results of this study have shown that stakeholders recognise the importance of the characteristics and features green buildings on property value. Some guidelines have been proposed as an outcome of the survey to encourage valuers to identify areas where the enhanced value or risk impact of green buildings could be translated into financial value as a more comprehensive assessment to property value. Data collection should be improved to include sustainability characteristics of green buildings and its performance and centrally stored in transactional databases (i.e. REALIS). Current valuation parameters can be enhanced to incorporate financial benefits of features such as lower risks due to reduced environmental impact and improved health and wellbeing of occupants. The reports by valuers should also reflect an opinion on some of these characteristics. Whilst it might be still too early to quantify the impact of green buildings on property value, what is certain is that more education and research is required in this area to enhance the knowledge of all stakeholders within the real estate industry and to ensure that the benefits of sustainable buildings are recognised by the industry and reflected in valuation methods. The situation will naturally evolve over time as the experience with sustainable buildings improves and more market evidence is available.

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Wissenschaft trifft Praxis III:

Building Information Modeling

Integration of FM and asset management expertise in digital 3D building models

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Abstract

Purpose: The research establishes a Conceptual Process Model (CPM) as shown in Figure 1 which shows how Facility Management (FM) and Asset Management (AM) know-how, 3D laser scanning and Building Information Modelling (BIM) can be combined with virtual design and simulation techniques to help managers make better decisions about feasibility report options and to add value and optimize existing buildings performance and quality.

Design methodology and approach: Mixed methods were used including a review of BIM literature and industry best practice. Seven semi-structured interviews were held with stakeholders from different stages in the BIM process. The initial CPM was subsequently refined during the research project based on feedback from the interviews. The 3D laser scanning element of the CPM was tested using two ZHAW university buildings and the findings triangulated with a feedback mechanism to further improve the model.

Originality and findings: The findings helped to develop a model which can be used by key stakeholders as a guide when considering the integration of FM and AM know-how, with 3D scanning in the creation of a BIM model for existing buildings, which constitute approximately 98% of the building stock. The focus is on combining existing know-how with the BIM process and simulation techniques to identify, simulate and evaluate the best building improvement options for feasibility reports prior to a decision to proceed. The CPM meets the need to develop a workflow with a focus on digitalisation of the existing built environment and creation of appropriate BIM model(s). The models can then be used for simulation purposes looking at cost benefit optimisation, energy efficiency, life cycle costing (LCC) etc. as well as creating virtual walk through models that can be viewed by end users, Facility Managers (FMs) and Asset Managers (AMs) to improve workplace environments and FM and AM operation.

Keywords: Facility Management (FM), Asset Management (AM), Building Information Modelling (BIM), 3D laser scanning, CAFM, Life Cycle Costing (LCC), COBie.

1. Introduction

BIM as a concept is not new and has been gradually evolving since the earliest days of computing. It is fundamentally a process that refers to a collaborative way of working, underpinned by digital three-dimensional technologies which unlock more efficient methods of designing, creating and maintaining assets (HM Government, 2012). The levels of BIM maturity are different by industry sector as well as country. The UK construction National BIM Report (NBS, 2014) states "BIM is now an industry norm" and their research figures report "awareness of BIM is now nearly universal and has risen from 58% in 2010 to 95% in 2013". In some countries (e.g. United States, Netherlands, Norway, Australia and Finland) the paradigm shift of adopting BIM has already happened, but in other areas (e.g. the DACH region of Europe) it seems to be somewhat more restrained (Detail, 2012). Considering a typical establishment phase of five to ten years for BIM in the design and construction sector (Kiviniemi, 2013), it is anticipated most countries will also soon move to adopt BIM as the norm. Familiarisation in the FM market is slower in gathering pace as the (BIM4FM, 2013) survey of the FM supply chain shows; "61.7% of respondents held the view that BIM can support the delivery of FM. Although, it was acknowledged that just over a third of respondents 35.3%, do not yet understand the intricacies of how this will be achieved".

The role of FM, AM and BIM is gathering pace with initiatives such as in Germany; "BOOM - Building Operation and Optimization Model" (Oltmanns, 2013) and the UK "Government Soft Landings (GSL)" process which will be mandated in 2016 for all UK central government projects, for new build and major refurbishments (BIM Task Group, 2014). This will require construction companies to carry our Post Occupancy Evaluations (POE) for up to 3 years after the completion of a building to prove the building design in operation and with increased involvement of FMs and AMs as the ones who have to manage the primary cost phase (use and operation). Such initiatives recognise the value and need for FM to be involved early in the design. This is also now reflected for new-build projects in the UK RIBA 2103 "Plan of Works" especially at stages 0 and 7, and in other countries norms (SIA, HOAI, Ő-Norm etc.). This leads directly to the question "how can BIM and FM/AM know-how be used for existing buildings?" and "how can we create digital building models for existing buildings/assets?"

As data acquisition and FM related costs (maintenance etc.) is a not a negligible cost factor (May, 2012) and taking into account the key drivers impacting FM, e.g. cost, sustainability, energy management, space etc. a good starting point seems to be to have the end in mind. A lot of information is needed in digital building models during the operational phase. Due to the fact there are a limited number of pilot projects, publications etc. dealing with this topic this paper tries to deliver a CPM, mapping out how 3D scanning for data acquisition, BIM standards as IFC, FM and AM Information know-how can be combined to optimize the operation of existing buildings and improve workplaces. It also explores the possible use of laser scanning for the "scan to BIM" creation of BIM model using a "smart workflow" (e.g. with different software products).

2. Literature review

There is often little testing of the primary product of the construction industry, "the building" done before irrevocable and often very costly decisions are made (Bazjanac, 2004). To try and address this and other issues in the UK, the Government published the Construction Strategy 2025 with four key targets 1) a 33% reduction in both the initial cost of construction and the whole life cost of assets, 2) a 50% reduction in the overall time from inception to completion for new-build and refurbished assets, 3) a 50% reduction in greenhouse gas emissions in the built environment and 4) a 50% reduction in the trade gap between total exports and total imports for construction products and materials (HM Government, 2013). They also include the strategic objective to have maturity Level 2 BIM file based rather than paper based (BSi, 2014)) for all public sector asset procurement by 2016, with equal applicability to private sector building, infrastructure, refurbishment and new-build projects. This requirement is now driving change in the construction industry which has embraced BIM. The process for specifying the information management in the construction and the operational phases of an asset or portfolio of assets as well as the collaborative production of information is outlined in PAS 1192-2 (BSi, 2013), PAS 1192-3 (BSi, 2014) and BS 1192-4 (BSi, 2014) respectively. Scanning recommendations are also made in PAS 1192-2 (BSi, 2013) specific to the "BIM Execution Plan". FM and AM are concerned with managing the key assets of an organisation at optimal whole life cost (BSi, 2014). However the integration of FM and AM expertise in the BIM process is an emerging area and there is still limited knowledge available on the subject (Kelly, Serginson, & Lockley, October 2013). To help define structured information for facilities, COBie-UK-2012 has been introduced via BS1192-4 and there are templates on the BIM Task Group website (BIM Task Group, 2014). These can be used to help capture data used in the commissioning, operation and maintenance of a project and to populate decision making tools as well as FM and AM systems (BSi, 2013). From an FM perspective the information management process must maintain the integrity of AM information to support the following activities related to AM: 1) defining AM strategies and plans, 2) implementing AM plans, 3) managing the AM lifecycle, 4) acquiring and managing asset knowledge, 5) managing the organization and its human resources, 6) managing and reviewing risk (BSi, 2014). Ultimately FM requires an Asset Information Model (AIM), linked to various enterprise systems, to be the single source of approved and validated information related to the asset(s). This includes data and geometry describing the asset(s) and the spaces and items associated with it, data about the performance of the asset(s), supporting information about the asset(s) such as specifications, operation and maintenance manuals, and health and safety information. (BSi, 2014).

To date the tangible benefits of adopting BIM are widely debated. There is a lack of real world case studies, especially in the case of existing buildings, despite new constructions representing a small percentage of the total building stock in typical year (Kelly, Serginson, & Lockley, October 2013). From a construction perspective the added value of BIM is now becoming evident as reflected in the article "No pain, No Gain in BIM" (Trebilcock, 2014) and include benefits such as; programme optimisation, clash detection and avoidance, construction simulation, temporary works integration, rig set up, BIM to manufacture, business efficiency, increasing market penetration and product integration. However, "the largest prize for BIM lies in the operational stages of the project life-cycle" (BIM Task Group, 2014). A BIM carries all information related to the building, including its physical and functional characteristics and project life cycle information (Azhar & Hein, 2011). The benefits from an FM perspective are a bit more difficult to validate but according to (BuildingSMART, 2010) include; entering data only once and reusing it throughout the life cycle of the project, blending geospatial and building information for planning, reducing requests for information and change orders, reducing rework, improving awareness of progress and current status. The (BIM4FM, 2013) survey highlighted how FMs think they will use BIM; life-cycle management (83.6%), improving efficiencies (82.2%), cost reductions (68.5%), carbon reductions (63.3%) and other (26%). The concerns raised were; cost (50.5%), integration with current technology and CAFM (50.5%), training (34.5%), data management (33%), time (32.5%), unknown technology (30.9%) and legal issues (16.8%).

Laser ranging systems have been in use in a variety of industries for decades, with the first patented instruments appearing as early as the late 1980's. 3D scanning was first applied in the Architecture, Engineering, and Construction (AEC) industry in the 1990's (Randall, 2013). Mobile and aerial scanning are now quickly becoming the standard method for creating digital city models. Scanners are also being used in other contexts for example to allow data acquisition at crime scenes or after natural disasters, accidents or to record the condition of road networks structural and architectural aspects of cultural landmarks and historic buildings (Randall, 2013). All these can serve as physical (digital) records. Scanning buildings has to date mostly used static terrestrial scanners based on a tripod system. One important myth to address is that scanners are optical systems, only what the scanner can "see" is captured, thus scanners cannot go through walls or other obstructions (Randall, 2013). Although static scanning technology delivers good results when scanning the outside of a building there are a number of limitations when scanning indoor locations due to the need to use "tie points" with physical targets to create a reference frame. The manual placement of the laser scanner on multiple stations interrupts the scanning and thus reduces the scanning rate (points per second). The placement of tie points requires additional manual effort. New technologies; Indoor Mobile Mapping Systems (IMMS) and Simultaneous Location and Mapping (SLAM) are emerging as the most prominent systems for indoor mapping (Thomson, Apostolopoulos, Backes, & Boehm, 2013). 3D scanning creates a foundation for a BIM approach by capturing existing conditions in a highly accurate, 3-dimensional format that can be used as a basis for developing project designs (Randall, 2013). PAS 1192-2 (BSi, 2013) also notes that a point cloud survey shall be provided to verify the completeness of the as-constructed model. For FM a key application of scanning is for as-built recording, or assessment of project performance to support project guarantees during the "as constructed" phase of a project (Randall, 2013).

3. Methodology

Mixed methods were used for the research including a review of BIM literature and relevant industry best practice. The Conceptual Process Model (CPM) shown in Figure 1 was then developed showing how FM and AM know-how, 3D laser scanning and the BIM process might be combined to offer decision makers a top level process tool to use when considering the setup of a BIM model for existing buildings and how it might be used to help optimize a buildings performance for improvement options such as energy use etc.

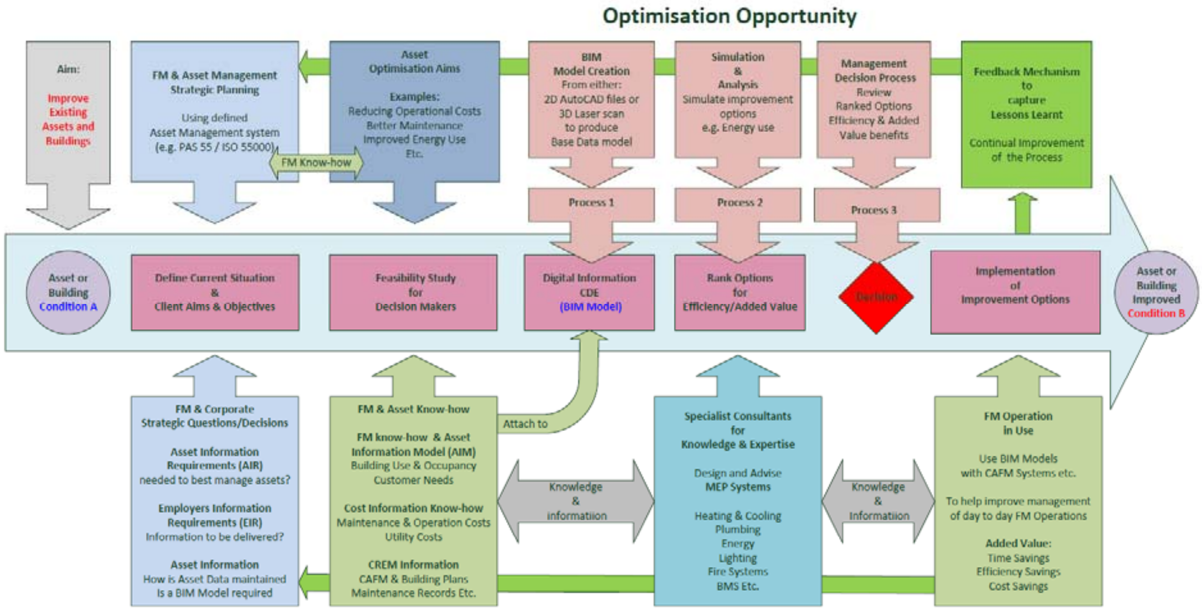

Figure 1: CPM: For the improvement of assets through the use of FM and AM know-how, 3D laser scanning and the BIM process for existing buildings

Feedback mechanism for improving the CPM

Seven semi-structured interviews were held with experts as per table 1 (stakeholders in different stages of the BIM process from Switzerland and the UK) to test the model and discuss how it might be improved. The questions for each interview were developed specific to the expert's field and experience. The draft CPM was discussed and refined throughout the interview process based on feedback and ideas created during the interview process.

Table 1: Details of the seven experts interviewed with their job title and focus of expertise

No	Job title and field of expertise
1.	**FM and real estate expert (UK):** strategic decision making with respect to a large portfolio of buildings, currently starting to use BIM in existing buildings
2.	**Architectural professional expert (UK):** advising clients about BIM responsibilities as well as 3D scanning and the creation of BIM models in Revit software
3.	**FM and real estate expert (UK):** creating BIM models clients buildings, both for new and existing buildings which are then used by their practicing FM staff
4.	**TEC engineering expert (Switzerland):** use of BIM in project management in hospitals with large TEC Engineering elements
5.	**M&E architectural professional (Switzerland):** MEP and creation of BIM models (ensuring clash detection and avoidance etc.) within an architectural context

6.	**Modelling and simulation expert (Switzerland):** simulation and modelling with the aim to make recommendations to clients about optimising their buildings
7.	**Senior project manager at the BIM Academy (UK):** focus on advising clients about BIM for the FM operational phase of buildings

The 3D scanning element of the CPM was tested using two existing buildings at the Zurich University of Applied Sciences (ZHAW). The findings were then triangulated with feedback from the interviews and the review of literature and best practice to improve the CPM.

1. Results and discussion

Two key themes highlighted in the interviews were 1) "the best way of approaching BIM is to learn by doing" (the authors agree with this) and 2) "when planning a BIM process always start with the end in mind". This is reflected in guidance from the PAS 1192-2 (BSi, 2013) which advocates following the principles of lean and ensuring the downstream uses of information are established at the start of the process in the Employers Information Requirements (EIR). The fact FM is not subject to the same obligations as the construction sector has meant FM is not yet fully engaged. This was confirmed by some interviewees who felt "FM has lost pace with industry; we should be in the driving seat not just letting the AEC industry to take the lead". The lack of engagement is also due to "a lack of good case study data on BIM especially with respect to FM". A key issue highlighted was that "many organisations are on the beginning of the BIM journey" and that there is a need to "educate staff and ensure they understand the BIM process". The GSL process means large construction companies with an in-house FM section are likely to be the first to see the real benefits of ensuring their designs are fit for purpose as they will end up living with the consequences. For smaller FM companies it may be more difficult as the question on most FMs minds is "what is the return on investment". For BIM models to be beneficial they need to be transparent with respect to the reliability and accuracy of data within them. There were some concerns raised with respect to "Issues around sharing potentially sensitive commercial data".

In addition to the two main themes above, Table 2 highlights the key findings which were established from feedback given during the interviews. This feedback was continually used to refine the CPM. A summary of key findings and observations from each interviewee are then detailed one by one.

Table 2: Summary of the key findings from interviews

No	Key findings
1.	**Communication:** is key to the success of the BIM process with the need for each stakeholder to engage and understand their roles and responsibilities in the process
2.	**Starting with the end in mind:** is key to ensure the BIM process has clear objectives and to ensure the relevant FM and AM knowledge is brought into the project as early as possible to realize the benefit to long-term operational costs
3.	**User specification and the level of information for BIM models:** needs to be clearly thought through if the models are to be accurate and useful to the FM/AM operation teams. Users need to consider how the teams will use the model(s) when specifying what information to attach to the model(s) – "what to put in and what to leave out"
4.	**Simulations:** require building geometrical and other data, but good simulations can use simplified models. Key is capturing adequate user and FM/AM operational data
5.	**BIM modelling for existing buildings:** requires a mix of methods to create accurate models; (2D plans, surveys, laser scans etc.). There is no direct tool that can create accurate plans direct from point clouds without survey validation checks. For each building clients need to evaluate the operational financial benefit to creating a model
6.	**The main benefits of the BIM process:** creating a strategic advantage in decision making and planning, transparency and ease of access to information and cost savings and efficiency of FM/AM resource in operation (especially if the BIM process can export data direct into CAFM systems)
7.	**The main barriers to BIM:** engagement with the BIM process due to complexity, education, familiarisation with the BIM language as well as client uncertainty about the business case and ROI. (If ROI can be verified it could become a key benefit)

1) FM and real estate expert (UK): "Experience has shown us communication is critical to ensuring the success of the BIM process, as we are all on a learning journey". When asked about the importance of BIM to FM/AM the response was "BIM is seen as strategic to our company as we see it will have financial implications and provide a sustainable edge in business". "We have just invested in workstations equipped with Revit software and are providing BIM training for our staff as well as familiarising ourselves with key documents such as PAS 1192-2 and PAS 1192-3". When asked about the key to making BIM work; "We need to work together with the client, architects and our supply chain to ensure every party understands their roles and is buying into the process". The key benefits were identified as “gaining full transparency of the cost of managing assets from cradle to grave as we are driven mainly by budgets”. The main benefit to clients being “improved planning of projects with better Life Cycle Cost (LCC) modelling of assets and CAFM compatibility”. Another key benefit is the “potential to attach FM/AM data into the BIM model”. The main barriers were identified as; complexity in terms of the “levels of data and integration of all players from inception and during design to all become familiar with the common language of BIM” and cost in terms of “who pays and what is the return on investment”. For “new builds we estimate a potential increase in cost of 3-5%”. For existing builds the question raised was “what advantage will the level of investment required bring us”. There were also commercial concerns raised; “attaching financial data to models might be commercially sensitive”.

2) Architectural professional expert (UK): A “key point which people sometimes forget is that although BIM will deliver savings in the construction phase the biggest potential savings are from FM in the operational phase”. As such “it is critical the BIM process starts with the FM end needs at the start of a project”. When asked what the key challenges are when working with BIM they find “clients are generally uneducated about BIM and a significant amount of our time is about getting them up to speed”. The practice use scanning extensively noting “if you send out a survey team to measure a large or complex building it can be very expensive, scanning allows a one-time capture of data in great detail and avoids the need to revisit site”. However people should be aware that “at the moment there is no reliable method for direct translation of point cloud data into 2D plans. Yes it is possible to use slicing techniques to produce rough line drawings but due to voids and complexity of what you see in terms of M& E equipment etc. a site validation check is still required”. “We have found through experience that the best way to build a BIM model is to use a combination of 2D plans with 3D scans and on-site checking by competent architects/engineers for the detailed stuff’. “We also have a library of BIM objects but often have to build these from scratch”.
When asked about BIM and existing buildings; “the main problem is access to information and its management. Government databases are often poor, out of date or badly managed meaning the FM/AM information, including sometimes basic plans, can often be lacking”. With existing buildings the “key question is for which buildings should a BIM model be considered, what level of information is required, at what cost and what will the benefits for the investment be”. With respect to the government the view was; “There is no way they will intrusively survey stock and for some buildings, especially the older ones coming to end of

their life. For those it is not worth the money to create a BIM model". "Essentially the main barriers to BIM in my view will be proving the business case and time required for a BIM".

3) FM and real estate expert (UK): When asked about working with BIM; "At first there were no BIM guidelines; we had to learn by doing". The main reason they invested in BIM was "better and quicker access to more reliable information about assets with the ability to make better decisions about how we manage and maintain those assets and the possibility to measure the outcomes". When asked what they see as the benefits of BIM to FM; "the main benefit is around transparency and efficiency, specifically with respect to FM staff time, not making wasted journeys, better planning etc." From a business perspective; "Our FM division is focused on managing portfolios of assets for our customers. We often find the level of their existing FM information is very poor and as such we see BIM as important as we believe in will allow us a competitive advantage if we can offer a better service to our clients, showing them how their assets can be better managed". When asked about the main lessons learned when setting up a BIM; "don't model everything. You need to think through carefully what level of data you want to model and make sure you have standard naming conventions and use the same convention in your CAFM for ease of data exchange and transfer". Another key area where they have spent a lot of time is "making sure that the data from the BIM can be imported to the CAFM system where we use if for daily FM tasks and likewise that is has the 2 way capability to be moved back to the BIM, it is crucially important that the data is to be kept up to date".

4) TEC engineering expert: (Switzerland): There is "no current in-house BIM experience" and so they decided to "use the BIM process for upcoming new construction projects and are seriously considering BIM for existing buildings". They have good experience with their existing FM IT-Tools (CAFM) and "expect lots of opportunities from BIM in FM". For example they feel "enriched 3D building models will help with strategic decisions regarding how they manage buildings if they change their management approach towards their assets". They have considered "this could be done by different types of simulations and optimization-tools but they would like to see the BIM processes as a key tool to help improve coordination of stakeholders in their projects". To them a key advantage was to have "a detailed history-data-set of each building should be the basis of an integrated BIM software solution". The central question raised was "we will decide about BIM for existing buildings based on the cost-value ratio. The ratio has to be balanced at least, taking this and with all the expected non-monetary benefits it would be something we would look to adopt". The expert would like the "BIM industry and research institutions to investigate costs and benefits of BIM for existing buildings in order to push this important BIM issue".

5) M&E architectural professional (Switzerland): They see "great potential in the use of BIM for issues such as quantity take-off, clash detection and avoidance etc." "BIM is an excellent tool for coordination and visualization allowing better decisions to be made better but only if everything is clear". "We also use the models for energy, thermal light, smoke, fire evacuation simulations and so on, however unfortunately not in the same software tool". The lack of compatibility "requires the BIM building geometry to be rebuilt because of the various software platforms". With respect to FM they feel "the FM industry needs to define its needs and specifications and think about interoperability between the BIM models and existing FM systems as the difficulty is to keep the virtual model up to date". "I think in the future, digital recordings of existing projects will become more important. In the future planning using BIM will become a very significant tool for renovation projects". "If the information content in the virtual and real buildings is consistent, a variety of benefits can be generated e.g. managing life cycle costs for components, risk assessments, etc." For us "energy and lighting simulations are at the forefront of today's applications. We can imagine that buildings in the future can be much better reviewed, and even the movement of goods and people flow can be simulated digitally".

6) Modelling and simulation expert (Switzerland): When asked what the key issues in modelling and simulation are; "knowing what you want to model and having a model that fits the simulation, or is adequate for the simulation". It is "important to understand simulations are just simulations of reality. They need to be achievable relatively quickly and to an acceptable level of accuracy at the right price". In some cases e.g. energy simulations the model doesn't have to be millimetre accurate but most be "closed" in a spatial sense. This is vital to allow the simulation software to work". "In the energy example once I have the basic geometry of a building established then I have to gather as much data as I can to feed into the model from the FM team". He has "options in the Design-build software where I can input data regarding wall thicknesses, materials, occupancy, and heat loads etc. I then play with variables and compare the result to actual energy bills to establish a model that has an acceptable level of accuracy to real life energy use". "Then and only then can I start playing with the building to see the effects of changing lights to LEDs or the façade etc.". "People are often surprised to hear for example that insulating the building may not be effective due to rebound effects at different times of year, as less energy for heating can mean more for cooling".

7) Senior project manager at the BIM Academy (UK): "Our main focus is on putting clients in the right strategic position with respect to BIM, asset management and FM to get better value out of their assets". When asked about client issue with BIM; "We find the main issue is many clients are not educated about BIM and their role and responsibilities with respect to the RIBA Plan of Works etc." When asked about BIM for new-build and existing buildings; "We are getting more and more enquiries for existing estates and also how clients can marry together BIM requirements for portfolios of new and existing buildings. "BIM for new-builds will, like CDM, become something we do on a day-to-day basis as part of the job". "The role of BIM consultancy for existing buildings has a longer shelf life, as clients struggle to catch up with how they manage and implement BIM for these buildings and understanding what is the ROI". From a management perspective "data standards, naming conventions and structure are so important. These are critical to allow seamless and accurate updating of databases. When it comes to scanning and BIM models there is "limited opportunities to automate the scan to BIM model process due to a whole array of issues such as line of sights, dealing with voids (missed scan areas) etc.". As technology gets better we are seeing the use of smaller portable self-registering scanners (e.g. CSIRO, Zebedee system using robotic technology called Simultaneous Localisation and Mapping (SLAM).) good for internal spaces, the key is to use the laser scanners appropriately". People need to understand that the management of a building does not change. The most up to date should stay in the FM operating system; people will just use BIM as an enabler for better visualisation, workflows etc. It's about improving how you manage the building and buying into that". "For existing assets, BIM models can be simple spatial models of the building with a fairly low level of information, the rest of the information can stay in in the FM operating system (CAFM etc.)".

The 3D laser scanning of ZHAW buildings: allowed the authors an opportunity to explore the scanning process for existing buildings from a practical FM perspective. A "FARO Focus X330 scanner" was used with five control network 139mm reference spheres to allow a common coordinate frame. The use of the spheres was found to be inefficient (especially for indoor scanning) as for each scan considerable thought one has to be put into being able to see 3 spheres from a previous (This is required to link scans). This causes issues with respect to "line of site" and linking spheres when going through doorways etc. The authors subsequently would suggest considering alternative methods for indoor scanning. The testing helped establish the time needed and the main issues; required accuracy, data acquisition, environmental and light conditions and software processing and registration of the point cloud data, filtering, classification (feature extraction/object recognition) etc. The scans were coordinated relative to each other without any geo-referencing. If the process is to be commercially viable a key factor was to understand how much time is needed for each of the process steps. To do this it is critical to establish how many scans are required and at what resolution and level of quality in order to be able to build an accurate 3D virtual representation of the building. This allows a calculation to be made of the time needed to complete the scan process. Based on supplier's advice and testing in the field approximately 25 minutes was calculated per scan; 18 minutes for actual scanning with an average logistics and set up time of 7 minutes per scan. Significant time also needs to be allowed for processing the data (which varies depending on the file size and number of scans). Experience showed this can be a slow process and prone to error.

5. Conclusion and recommendations

The practical experience gained through the two laser scanning exercises helped the authors understand the advantages and limitations of laser scanning. It became clear through discussions that scanning is a very important tool for allowing accurate measurements for modelling. In terms of the overall time to create a good model with adequate FM/AM information, the scanning element is small and as such should be considered money well spent. Clients need to have the end in mind when they consider how to create models which are accurate and have the right level of FM/AM information attached. To be commercially viable a business case should be put in place taking into account key issues such as; resources and the technology, software and computing power required which can be expensive and require significant effort to become familiar with. Clients may wish to use a third party as the time and investment cost can be significant. Specialist suppliers will be familiar with the data formats and standards and will be able to help clients' clarify their needs. Clients also need to consider how they will use and view BIM models. They may wish to invest in BIM viewer software to avoid having to purchase and maintain costly equipment and full versions of software (BSi, 2013). Increases in 3D laser scanning technology will inevitably mean cheaper scans and potentially more options in the future. The architectural interviewee experts reported a notable increase in clients wanting BIM models for existing buildings believing they will constitute the larger market share for BIM in the future. Although it was not possible for the Authors within the time frame to actually build their own BIM Model (This is the next step) the experience gained and interviews indicate that the BIM process will offer clients and FMs many benefits. The process to automate 2D drawings from scanned data seems to have some way to go before this is possible and to get an accurate model still requires checking in the field by competent and qualified experts. The Authors believe as scanning technology develops indoor scanning will improve and so automation may become easier. It is clear communication is key and that more education is needed about BIM across all stakeholders with better case study history, especially with respect to ROI and the range of benefits for FM from scanning and BIM. Once this becomes established and driven by the government's initiative BIM will become the norm for the FM and AM industry.

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How Facility Management can use Building Information Modelling (BIM) to improve the decision making process

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Abstract

Building Information Modelling (BIM) is changing the way the construction industry works and whilst designers and constructors are already rapidly implementing BIM in their practices, its potential use for facilities management is still not clearly identified and existing case studies show only a marginal use. The research presented in this paper aims to identify the opportunities and barriers related to the integration of BIM and Facility Management (FM) knowledge. It investigates how FM and BIM can add value to and improve the transition process from construction to operation by capturing and making better use of relevant FM information. A focus group workshop approach was used with a group of subject matter experts (SME) from across the building whole life process. The workshop was the first step of a three-year project aimed at understanding how BIM can support sustainable FM decisions.

BIM offers FM an opportunity as a process tool to enable a more informed decision-making process. The paper summarizes the theoretical applications of BIM to FM and presents the outcomes of the workshop. FM can use BIM as a unique source of data that needs to be transformed into usable information for day-by-day activities. The creation of BIM standards is necessary to enable data exchange with other software. Cultural and behavioural aspects, as well as soft services, should be integrated within the BIM model.

Keywords: Facilities Management, BIM, decision making, Building Operation

1. INTRODUCTION

The gross value added (GVA) from the construction industry to the UK economy in 2012 was £83 billion, 6% of the total economy of the country, with over 2.12 million workers employed in Q4 2013 (Rhodes, 2014). Although the industry suffered from two contractions during the recession it is estimated that the construction sector will grow globally by over 70% by 2025 (Global Construction Perspectives and Oxford Economics, 2013).

The UK Government has created, together with the UK construction industry, an industrial strategy aimed at helping the growth of British businesses and at putting “Britain at the forefront of global construction over the coming years” (HM Government, 2013). The Government goal is to lower initial and whole life costs by 33%, achieve a 50% time reduction from inception to completion, lower emissions by 50% and reduce by 50% the gap between total exports and total imports of products and material for construction. As part of the strategy the UK Government (HM Government, 2012) is promoting a smarter and more digital industry to achieve innovation and as part of this, Level 2 BIM implementation will be mandatory for all centrally procured Government contracts from 2016. This means that collaborative 3D BIM will be necessary, with all project and asset information, documentation and data being electronic and available in a COBie UK 2012 format. To achieve this, the UK BIM Task Group has been formed with the purpose of supporting and helping deliver the government objectives.

Although the term “BIM” was created around 2003 (Saxon, 2013) only recently the construction industry has started implementing it, driven mainly by Government, major private owners and institutional clients. The NBS National BIM report (2014) shows that 54% of the over 1000 UK construction professionals who took part of the survey had used BIM at least once during 2013, with an increase of over 40% compared with 2010 results whilst the percentage of participants unaware of BIM has reduced from 43% in 2010 to 5% in 2013. Among the respondents aware of BIM, 93% of them stated that they would use BIM in the next three years, which indicate that the Government’s BIM mandate has driven the whole industry. With an increasing number of companies using BIM for their projects, numerous case studies are now available to suggest the benefits of using BIM during design and construction, showing higher potential in exploring opportunities and finding solutions to problems, when compared to standard stand-alone 2D and 3D drawings (British Standards Institution, 2010; Salman, 2011; Bryde et al. 2013).

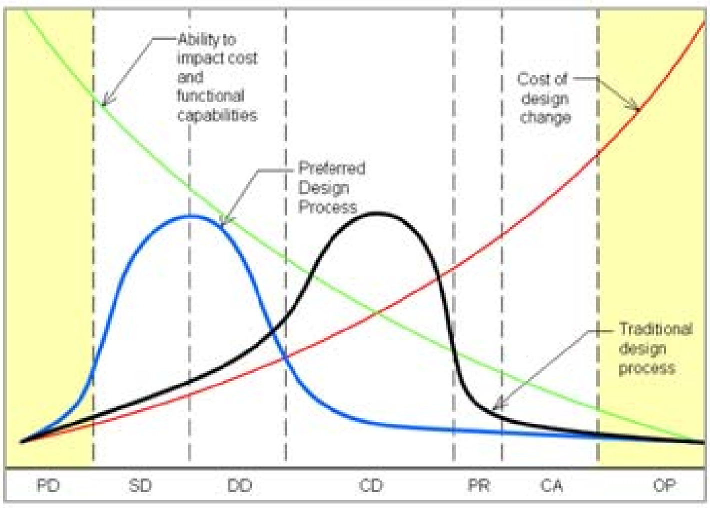
However, once a building is complete and in use, the potential use of BIM for facilities management is still not clearly identified. Beyond maintenance schedules and equipment information and location, there is no mention of the potential use of BIM for a decision making process (Eadie et al., 2013). BIM seems to be a tool aimed to simplify FMs job (Morton, 2011, IFMA, 2013) and ease the initial process of entering FM information after a building is handed over (Eastman et al. 2011) and there are few case studies currently available like the Sydney Opera House (CRC, 2007) and the Atlantic College (Gillard et at. 2008).

This paper presents preliminary findings of an ongoing three years study on how BIM could be used to manage buildings in a more sustainable way. It presents a review of the literature on how BIM is changing the construction phases and what the possible implications of BIM for FM might be. The main focus of this paper is on the findings derived from a stakeholders workshop held in London that highlighted the barriers, opportunities and added value of BIM for facilities management.

2. BIM AND THE BUILDING LIFE-CYCLE

There is a multitude of different definitions of BIM (HM Government 2012, McGraw Hill Construction 2008, Woo et al. 2010) but for the purpose of this paper the buildingSMARTalliance (2007) BIM definition will be adopted "a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward. A basic premise of BIM is collaboration by different stakeholders at different phases of the lifecycle of a facility to insert, extract, update, or modify information in the BIM to support and reflect the roles of that stakeholder. The BIM is a shared digital representation founded on open standards for interoperability".

The opportunity to integrate physical and functional characteristics of a facility in a unique intelligent model shared between stakeholders makes BIM a powerful tool that enables a decision making process at earlier stages, with greater effectiveness and lower cost. In 2005 Patrick MacLeamy presented at the AIA National Convention the graph presented in figure 1, now known as "MacLeamy curve" (Anderson, 2010).



PD: Pre-design
SD: Schematic design
DD: Design development
CD: Construction detailing
PR: Procurement
CA: Construction Administration
OP: Operation

Figure 2: MacLeamy curve

The curve represents how the cost of changes (red line) and the effectives of those changes (green line) vary during the timeline of a project, from pre-design to operation. In the traditional design process (black curve) changes are made when the effectiveness is lower and the cost of changes higher, while in a preferred design process (blue curve) the decision process is complete before the construction documentation phase, when the effectiveness of the decisions is higher and cost is lower. To achieve the blue curve a "shift of effort", as MacLeamy called it (Light, 2011), is needed. But in order to have all the information available during the first stages of the project, constructors, installers, fabricators, suppliers and facilities managers need to work together with designers (The American Institute of Architects, 2007) using BIM as a tool to model and simulate the project and thus identify synergies, opportunities and arrive to optimum solutions.

An integrated and collaborating team working on a single building information model can facilitate the design-construction process, reducing cost, schedule and request for information (Luth et al., 2014). Breaking down the contractual silos that characterised the construction industry will benefit the facility throughout all of its life cycle. Therefore, a detailed BIM model accompanied with relevant performance analysis of the building before it is build can potentially lower operational costs, enabling savings during the building life span.

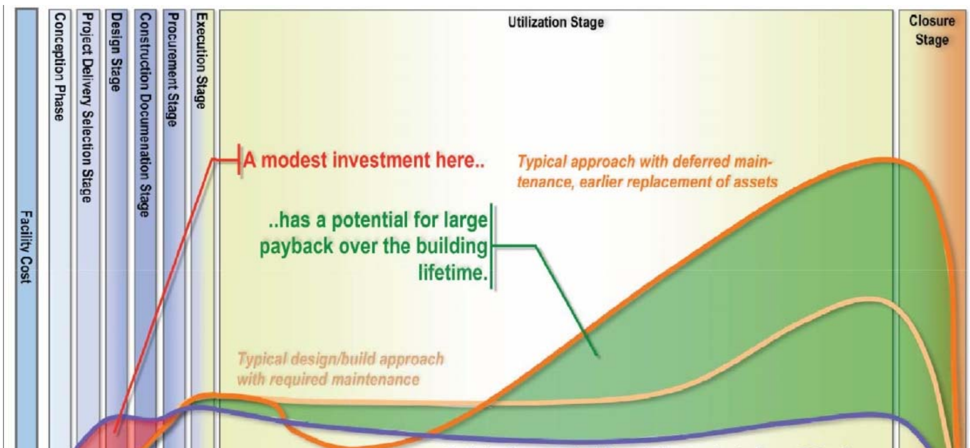


Figure 3: Notional Chart of Life-Cycle Facility Costs (Anderson, 2010)

The most important part of the BIM definition is that "…it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward…". BIM also serves as a graphical representation of a building but above all is a tool for decision making and analysis, based on data, which can be used during all stages of a building. From the inception of a building as an idea and a sketch, where preliminary data can be inputted to track progress and various performance aspects and share the information with the design team, all the way to a completed building that is operating where data is shared between facilities managers, maintenance engineers, occupants and owners among others.

More specifically, from a facilities management perspective, the main benefits achieved when integrating BIM and FM as suggested by IFMA (2013) are that it:

- Reduces costs: accurate and complete data ready for use when building completed, lowers data capture and O&M costs
- Improves performance: more complete and accessible FM data allows faster analysis and correction of problems and fewer breakdowns. Supports happier and more productive users
- Integrates systems: data from BIM integrates with CMMS/CAFM/BAS, updated over the life of a building.

Although some of these benefits are still not easily achievable, like the integration of BIM and CAFM systems that is in its infant stage (Gnanaredman, M. and Jayasena, H. S. 2013) with only few pilot projects available like BAM's "Project Robin" (BAM, n.d.), the list suggests that once a building is complete and handed over the BIM model will mainly be used as an intelligent database, potentially losing its function of decision support and as a tool for analysis. Therefore, a question can be raised as to whether facilities managers need to look at BIM as an opportunity to understand the building, its behaviour and its future opportunities. If BIM cannot bring these benefits, then it will not be a major improvement for the FM industry but simply an add-on of the current building management software.

3. BIM FM WORKSHOP

A one day workshop sought to explore practical problems associated with integrating BIM into FM and to identify knowledge gaps that the industry identify as keen to be filled was held in January 2014 in London at the University of Greenwich. The aim of the workshop was to begin to explore some of the issues related to the implementation of FM and BIM, as identified through the literature review and analysis of similar events, answering the following questions:

Question 1: "How can BIM help Facility Managers to manage their facilities?"

- How can FM be brought into the early design stages to review operational practicality and cost issues of design?
- How can software tools be adapted to help deliver the best operational management

systems during the transition from construction to operation?

- How can FM and BIM help improve whole life and operational costs?
- What is the best way to improve the provision of O&M information in electronic searchable formats?
- How can BIM help FM manage their operations and add value to their business?

Question 2: "Intelligent BIM; How can BIM help Facility Managers to manage buildings in a more sustainable way?"

- How can soft services be included in BIM?
- What aspects of the sustainable agenda can be integrated with BIM?
- What other aspects or functionality should be included in BIM to support FM operational needs?

Question 3: "What kind of data does FM need in order to use BIM?"

- How should data be organised in BIM to allow WLC and LCC analysis during the planning and on- going operational phases?
- How can energy management data (measuring and monitoring) be included in BIM to allow accurate measurement of long term energy use?
- How can data that is important for operation be separated from data that is for archive purposes?
- What FM operational information is required for the BIM process and when?
- COBie and data management issues?

Question 4: "Research, education and policy". What are the key areas of research that would benefit from the integration of FM and BIM and the value it can bring?

- How can BIM be used to help Facility Managers in existing buildings?
- What are the advantages of including BIM in NBS and other forms of contract?
- What education and possible opportunities exist to develop BIFM training and qualification?
- How can we build up a database of case studies to show the operational benefit of BIM to facility managers?

The workshop was by invitation only and the 22 attendees were pre-selected to represent a variety of stakeholder groups involved over the whole life process (FM service providers, clients, academia, UK Government, professional bodies and FM contractors). The workshop started with three presentations, setting the background outlining the potential application of BIM to FM. The first one emphasised the many questions that are still unanswered regarding the management of buildings via BIM, for example what should be modelled from the facilities management perspective and how can a FM-BIM be integrated into strategic built asset management. The second presentation highlighted how the UK Government wants to change the construction industry by 2025 and how BIM and Soft Landings are milestones in order to achieve a 33% reduction in costs, 50% faster delivery and 50% lower emissions. The last presentation provided a brief description of how BIM is currently used by the construction industry, what benefits have been reported from companies that have used BIM, what changed once a building was completed and handed over and what are some of the potential uses of BIM for FM researched so far.

After the presentations, participants were divided into three groups. The groups were organised so as to have two representatives of the academic world in each group, adding other participants to each group based on their knowledge and expertise in the topic areas covered during the workshop. Groups remained unchanged during the first part of the workshop (question 1 and 2) and were subsequently modified for the third and fourth question following the same organizational logic. For each session each of the groups had a total of 15 minutes to discuss the topic and gather ideas on flipcharts followed by a 5 minute presentation of the results to other groups.

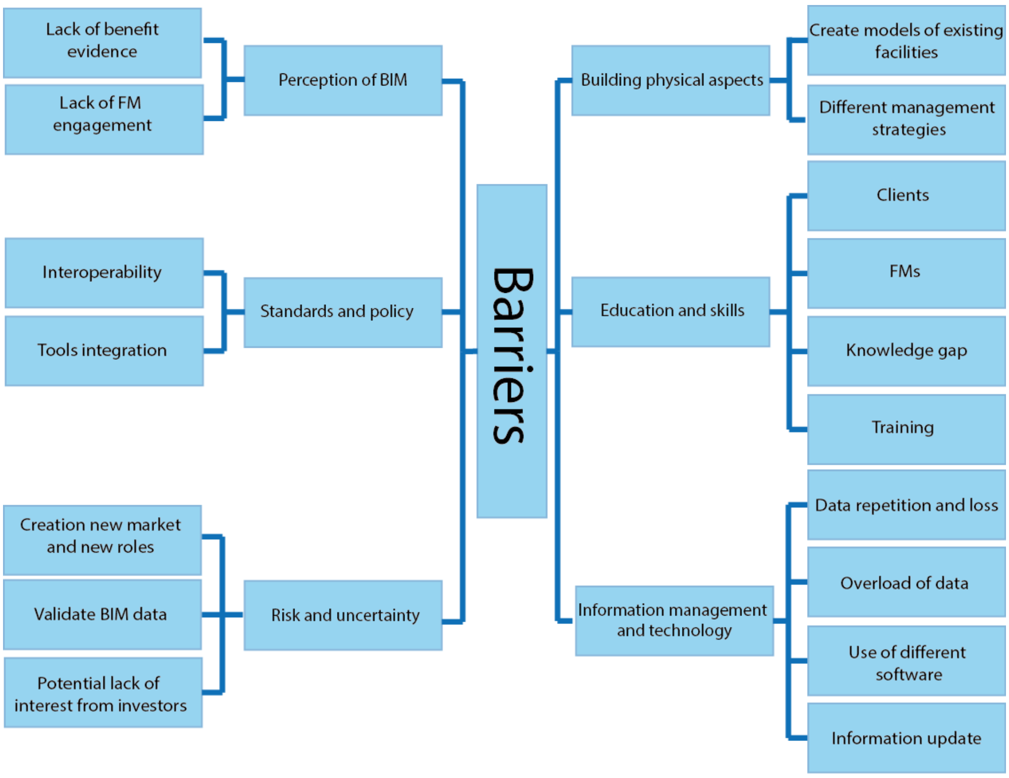
4. RESULTS AND DISCUSSION

The presentations were recorded and subsequently analysed together with the flipcharts used during the group discussions using a qualitative analysis approach in four stages, as proposed by Lacey & Luff (2007):

1. Transcription of all presentations and comments recorded
2. Organising the data into four different questions
3. Preliminary coding of interesting concepts
4. Identification of themes

A thorough analysis of the transcriptions and flipcharts was then conducted, taking into account all the concepts that immerged during the workshop. Subsequently a further one day workshop was held at the Zurich University of Applied Sciences (ZHAW) in Switzerland to supplement the analysis with additional findings which then led to the organisation of the findings into three themes: barriers, opportunities and added value of implementing BIM for FM.

BARRIERS



Perception of BIM

Even though facilities managers consider BIM a facilitator rather than an inhibitor to their work (Carbonari, 2014) BIM is still a new topic and its potential is still not fully understood. The industry is aware of the possible use of BIM for enhanced building maintenance (McGraw Hill Construction, 2014) but still there is not enough evidence to convince facilities managers to fully embrace this new technology. The current lack of interest is slowing the process of implementing BIM for FM in contrast of what is happening in the rest of the construction industry.

Building physical aspects

It is estimated that approximately 75% of the current UK Commercial Buildings will still exist in 2050 (Ravetz, 2008); therefore, implementing BIM for existing buildings, seems to be a great concern for both the construction industry and facilities managers. There is the need to understand to which extent the model has to be created, what are the necessary data to make a

BIM model helpful for FMs and who will be in charge of implementing it and its on-going management.

Furthermore, companies can have different attitudes towards facilities management and this can change the potential use of BIM. Different management strategies imply different breadth and depth of information to be stored and recorded during the building life and need to be taken into consideration while implementing the model.

Standards and policy

In order to assist the industry adoption of BIM, there is a need to create a unique BIM standard preferably at an international level. This will put pressure on software developers to create globally applicable tools that will make information and data exchange between other tools a straightforward process. The UK Government is currently demanding COBIe files as output from a BIM model for public projects, but as long as there is not a unique standard interoperability between software and integration, this will be hard to achieve.

Education and skills

BIM is a fairly new topic and the construction industry is in the middle of the learning curve. If the stakeholders are not aware of the potential of BIM, there is the risk they won't be interested in investing money, time and effort to implement it, therefore losing future opportunities. Training will help stakeholders to understand what can be achieved using a BIM model and how it can be helpful to accomplish the company's goals.

Risk and uncertainty

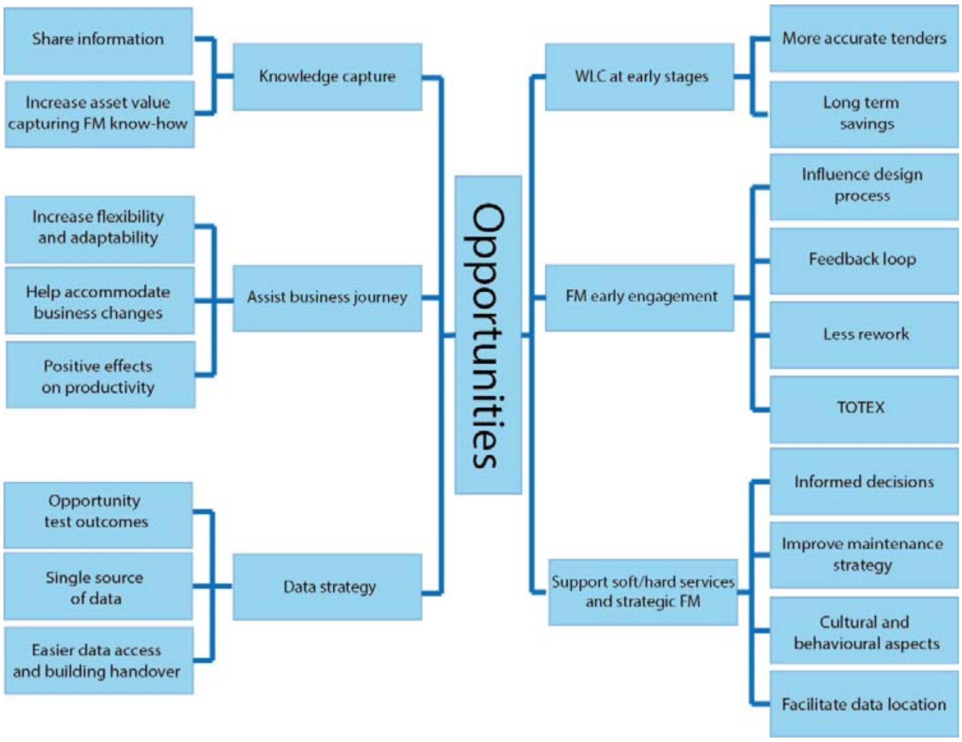
The workshop participants agreed that the new BIM market might create new BIM job roles and specific courses: this would lead to a fragmentation instead of the ideal of integration and shared information that should underpin a BIM model. All the stakeholders should understand how the model works, what its purpose is and how to use it as part of their work. Until the stakeholders mind won't change, investors won't probably be interested in including FM at the design stage or creating BIM model of buildings that will be sold once the building is completed.

Information management and technology

Once the BIM model is handed over to FM not all the information within the model will be useful for managing the facility during its operational phase so the model may be overloaded with unnecessary information. The information will then be exchanged with various other software such as computerized maintenance management systems, building automation systems, energy management systems and electronic document management systems, and the data might be duplicated or lost during the process.

During the life cycle of the building, the information about changes needs to be recorded in a unique format, but it is still not clear who will be in charge of this task. Also, it is necessary to decide whether a kind of information should be included in the BIM model or rather in different software.

OPPORTUNITIES



Knowledge capture

Sharing a common model between all the stakeholders allows the sharing of information in a more rapid and effective way: once a change is made the model will automatically show if it could cause any issue or if other changes are needed, unlike what happens with 2D/3D stand-alone drawings.

If facilities managers are involved in the design process, giving feedback on the decisions made by designers and architect using the visualisation and walkthrough opportunities provided by BIM, the asset will have an increased value and the management process will be easier during the building life. BIM will enable designer, engineers, builders, suppliers, clients and facilities manager collaboration and information sharing, allowing the industry to break down the silos in which the different teams have worked in the past.

WLC at early stages

The inclusion of FM in the design stage and the consequent collaboration on a single model facilitate the capture of detailed information on the building before it is built. The information can be used during the tender process and to model the building behaviour over time, identifying potential alternatives, and make informed decision that will have a greater impact on the whole life cost of the building.

Assist business journey

During the life of the building, BIM can be used to accommodate the business changes, modelling different solutions and helping the decision-making process: BIM can be used as a tool to increase flexibility and adaptability of a building, improving the quality of the work environment and therefore having positive effects on productivity.

FM early engagement

BIM allows facilities managers to be involved in the design stage, giving FM the opportunity to visualise the building and influence the design process. This will create a feedback loop and a continuous improvement of buildings, and consequentially less need to rework during the construction phase. FM can also use the model to calculate, once the design is complete and before the construction begins, the operational expenditure (OPEX) that together with the capital expenditure (CAPEX) gives the total expenditure (TOTEX) of the building during its whole life.

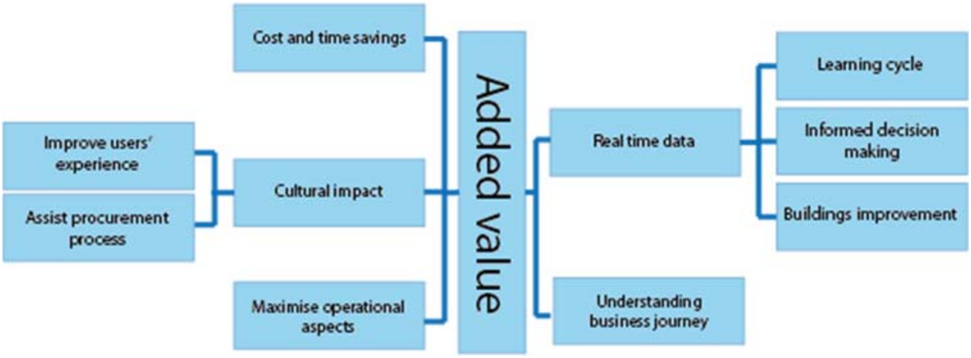
Data strategy

Identifying the data needed by facilities managers for managing the building during the pre-design stage helps in collecting this data into the BIM model before handover, providing a single source of data fit for purpose. This will allow facilities managers and clients to set the targets at the beginning of the process and test the outcomes while the building is in use. BIM can also facilitate the building handover and provides an easier access to data, as it contains all the information needed to operate the building in a single database.

Support soft/hard services and strategic FM

The data within the model and collected during the life of the building can be used to make informed decisions together with the opportunity to improve the maintenance strategy. Data can be located in an easier and faster way, for example by using mobile devices directly on site. The workshop participants agreed that the model should include cultural and behavioural aspects in order to enable more informed decision making processes, tailored on the building and users. Unfortunately, presently available software on the market does not present these features as of yet, to the authors' knowledge.

ADDED VALUE



Cost and time savings

Various case studies show that BIM has a positive impact in cost and time savings (Bryde et al., 2013; Barlish and Sullivan, 2012) reducing errors, omissions and rework. Companies fully committed with BIM report a return of investment over 25% (McGraw Hill Construction, 2014)

Real time data

BIM, as an intelligent model automatically updates the model once a change is made: this can help facilities managers to make decision based on real time data about the building behaviour and use. The information stored within the model can create a learning cycle, a deeper understanding of the building dynamics and a constant improvement throughout the facility life cycle.

Cultural impact

BIM can have a positive impact also on the building users: improved buildings can enhance the users' experience and a deeper understanding and analysis of the building can lead to a building tailored on the users and companies' needs. A deep understand of the building in use, from pre-design to the building end of life leads to reduce costs and waste, especially of the energy use.

The "shift of effort" (MacLeamy, 2004) has as a consequence that all the design decisions are made before the design detailing; at the procurement stage all the information is available and can be used for more accurate tenders.

Maximise operational aspects

Facilities managers can use BIM not only for location and visualisation purposes but also as a tool to maximise operations and maintenance: the data stored within the model can be used for analysis of the building during its life, revealing information useful for future strategies.

Understanding business journey

A building has to accommodate the business' needs and facilities managers can use BIM to review what has changed in the past in order to create hypotheses and scenarios of what might happen in the future.

5. CONCLUSION AND RECOMMENDATION

The Government strategy to have all government buildings built with a BIM model by 2016 has mobilised the construction industry into change and the adoption of BIM as a process. The RIBA 2013 plan of works introduces BIM in Stage 0 – Strategic Definition. At this early point in a project a matrix is required to define the roles and responsibilities and the client should "consider the merits and protocols of using a BIM model to help deliver sustainability aims". Feedback from the workshop suggests clients and facility managers' perception of BIM is unclear and the lack of knowledge and education around BIM means many clients are unaware of their responsibilities in the RIBA process and as a result facility managers are often left out of these critical early discussions.

It is critical that facility management is involved in the early stages as they understand the culture of the client and will help the client make informed decisions, meet their requirements to provide relevant information and develop a well thought out information and data strategy and to help plan for Stage 6 – Handover and Closeout where the Soft Landings and BIM End of Construction Model Data so that the right information is captured and prepared for handover to the facility management team and the project performance reviewed. Stage 7 – In Use, addresses the need to manage and update the BIM model on-going.

In order to maximise operational time and cost savings and deliver the potential cultural benefits facility managers and others keys stakeholders need to bring the benefit of their knowledge into the process to deliver maximum added value. This will allow facility management to use BIM to improve the decision making process when considering both new and existing buildings. Most of the workshop delegates all recognised they are on a BIM journey and in order to ensure the success of BIM it is important for all stakeholders to educate themselves and engage fully with the process.

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