UNIVERZA V LJUBLJANI
EKONOMSKA FAKULTETA

MAGISTRSKO DELO

ANALIZA UPORABE INFORMACIJSKEGA MODELIRANJA GRADENJ V SLOVENIJI

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IZJAVA O AVTORSTVU

Podpisani Saša Kiraly, študent Ekonomske fakultete Univerze v Ljubljani, avtor predloženega dela z naslovom Analiza uporabe informacijskega modeliranja gradenj v Sloveniji, pripravljenega v sodelovanju s svetovalko doc. dr. Aleša Saša Sitar.

IZJAVLJAM

1. da sem predloženo delo pripravil samostojno;

2. da je tiskana oblika predloženega dela istovetna njegovi elektronski obliki;

3. da je besedilo predloženega dela jezikovno korektno in tehnično pripravljeno v skladu z Navodili za izdelavo zaključnih nalog Ekonomske fakultete Univerze v Ljubljani, kar pomeni, da sem poskrbel, da so dela in mnenja drugih avtorjev oziroma avtoric, ki jih uporabljam oziroma navajam v besedilu, citirana oziroma povzeta v skladu z Navodili za izdelavo zaključnih nalog Ekonomske fakultete Univerze v Ljubljani;

4. da se zavedam, da je plagiatorstvo – predstavljanje tujih del (v pisni ali grafični obliki) kot mojih lastnih – kaznivo po Kazenskem zakoniku Republike Slovenije;

5. da se zavedam posledic, ki bi jih na osnovi predloženega dela dokazano plagiatorstvo lahko predstavljalo za moj status na Ekonomski fakulteti Univerze v Ljubljani v skladu z relevantnim pravilnikom;

6. da sem pridobil vsa potrebna dovoljenja za uporabo podatkov in avtorskih del v predloženem delu in jih v njem jasno označil;

7. da sem pri pripravi predloženega dela ravnal v skladu z etičnimi načeli in, kjer je to potrebno, za raziskavo pridobil soglasje etične komisije;

8. da soglašam, da se elektronska oblika predloženega dela uporabi za preverjanje podobnosti vsebine z drugimi deli s programsko opremo za preverjanje podobnosti vsebine, ki je povezana s študijskim informacijskim sistemom članice;

9. da na Univerzo v Ljubljani neodplačno, neizključno, prostorsko in časovno neomejeno prenašam pravico shranitve predloženega dela v elektronski obliki, pravico reproduciranja ter pravico dajanja predloženega dela na voljo javnosti na svetovnem spletu preko Repozitorija Univerze v Ljubljani;

10. da hkrati z objavo predloženega dela dovoljujem objavo svojih osebnih podatkov, ki so navedeni v njem in v tej izjavi.

V Ljubljani, dne _____ Podpis študenta:_____

KAZALO

KAZALO TABEL

KAZALO SLIK

SEZNAM KRATIC

2D – dvodimenzionalno
3D – tridimenzionalno
4D – štiridimenzionalno
5D – pet-dimenzionalno
6D – šest- dimenzionalno
7D – sedem-dimenzionalno
ABC – (ang. Activity Based Cost); stroški posameznih aktivnosti
AC – (ang. Actual Cost); dejanski strošek
ACWP – (ang. Actual Cost of Work Performed); dejanski strošek opravljenega dela
AEC – (ang. Architecture, Engineering and Construction); arhitektura, inženiring in gradnja
AIA – (ang. American Institute of Architects); Ameriški inštitut arhitektov
AIM – (ang. Asset Information Model); .model informacij o sredstvih (zgrajenih objektih
AIR – (ang. Asset Information Requirement); zahtevane informacije o sredstvih (zgrajenih objektih
ang. – angleško
B-C-F – (ang. Baseline-Current-Future); predvidena, trenutna, prihodnja
BCWP – (ang. Budgeted Cost of Work Performed); planirani stroški za opravljeno delo
BCWS – (ang. Budgeted Cost of Work Scheduled); planirani strošek načrtovanega dela
BIM – (ang. Building Information Modeling, Building Information Model); informacijsko modeliranje gradenj
BLM – (ang. Building Lifecycle Management); program za management življenjskega cikla gradnje
CAD – (ang. Computer Aided Design); računalniško podprto konstruiranje
CDE – (ang. Common Data Enviroment); skupno podatkovno okolje
CNC – (ang. Computer Numerical Control); računalniška numerična kontrola
COBie – (ang. Construction Operations Building Information Exchange); Specifikacija za tabelarični prikaz informacij, zapisanih v BIM-modelu
CPM – (ang. Critical Path Method); kritična pot
CRT – (ang. Cathode Ray Tube); katodna cev
DARS – Družbe za avtoceste v Republiki Sloveniji
DRI – Družba za razvoj infrastrukture
EAM – (ang. Energy Analysis Models); računalniški modeli za energetsko analizo
EIB – (ang. European Investment Bank); Evropska investicijska banka
ERP – (ang. Enterprise Resource Planning); program za načrtovanje virov podjetja

EU – (ang. European Union); Evropska unija
EV – (ang. Earned Value); prislužena vrednost
EVA – (ang. Earned Value Analysis); analizo prislužene vrednosti
EVM – (ang. Earned Value Management); metoda prislužene vrednosti
EVMS – (ang. Earned Value Management System); sistem za celovito obvladovanje prislužene vrednosti
EVT – (ang. Earned Value Technique); tehnika prislužene vrednosti
FGG – Fakulteta za gradbeništvo in geodezijo
IAI – (ang. International Alliance for Interoperability): Mednarodno združenje za interoperabilnost
IDM – (ang. information delivery manuals); priročnik z informacijami
IFD – (ang. International Framework for Dictionaries Library); mednarodni katalog konceptov in terminov
IKT – informacijsko komunikacijske tehnologije
ISO – (ang. International Organization for Standardization); Mednarodna organizacija za standardizacijo
IZS – Inženirska zbornica Slovenije
LCC – (ang. Life Cycle Costs); stroški življenjskega cikla
LoD – (ang. Level of Detail); stopnja podrobnosti (geometrijske vsebine)
LOD – (ang. Level of Development); stopnja razvitosti modela
LOI – (ang. Level of Information); stopnja informacij
MIT – (ang. Massachusetts Institute of Technology); Tehnološki inštitut Massachusettsa
MVD – (ang. Model View Definition); opredelitev pogledov končnega BIM-modela
NBIS-US – (ang. National BIM Standard-United States); Ameriški nacionalna zveza za standardizacijo BIM-pristopa
NBS – (ang. National Building Specification); Nacionalni odbor za gradbeno specifikacijo
NIST – (ang. National Institute of Standards and Technology); Ameriški inštitut za standarde in tehnologijo
PADL – (ang. Part and Assembly Description Language); programski jezik za opis objektov in sestavov
PBS – (ang. Product Breakdown Structure); struktura izdelka / obseg projekta
PDF – (ang. Portable Document Format); prenosljiv format dokumentov
PERT – (ang. Program (or Project) Evaluation and Review Technique); puščični mrežni diagram
PIS – projektni informacijski sistem
PLM – (ang. Product Life management); program za management življenjskega cikla izdelkov
PMBOK – (ang. Project Management Body of Knowledge); Vodnik po znanju projektnega vodenja
PMIS – (ang. Project Management Information System); projektni informacijski sistem
PRONTO – (ang. Program for Numerical Tooling Operations); program za orodjarske numerične operacije
PV – (ang. Planned Value); planirani strošek
RS – Republika Slovenija

siBIM – Slovensko združenje za informacijsko modeliranje v gradbeništvu
TU – (nizozemsko Technische Universiteit); Tehnična univerza
UK – (ang. United Kingdom); Združeno Kraljestvo
VB – Velika Britanija
WBS – (ang. Work Breakdown Structure); struktura del oziroma aktivnosti
XML – (ang. eXtensible Markup Language); razširljiv označevalni jezik
ZAPS – Zbornica za arhitekturo in prostor Slovenije
ZJN – Zakon o javnih naročilih
ZJNPOV – Zakon o javnem naročanju na področju obrambe in varnosti
ZJNVETPS – Zakon o javnem naročanju na vodnem, energetskem, transportnem področju in področju poštnih storitev
ZPVPJN – Zakon o pravnem varstvu v postopkih javnega naročanja

UVOD

K pisanju magistrskega dela s pričujočim naslovom me je spodbudilo desetletno delo v podjetju, ki deluje v gradbeni panogi kot proizvajalec, monter in serviser hitro tekočih industrijskih vrat. Pri delu se pogosto srečujemo s konflikti napačnih ali nedorečenih informacij, največkrat kot posledica komunikacijskega šuma v verigi naročnik – izvajalec - zastopnik/prodajalec - proizvajalec. Menim, da bi se težavam lahko ognili in ustrezno prilagodili že pri sami zasnovi izdelka in pozneje pri njegovi montaži ter servisiranju, če bi komunikacija potekala drugače. V publikaciji McGraw-Hill avtorji navajajo, da je produktivnost gradbeništva v zadnjih štiridesetih letih močno stagnirala v primerjavi z ostalimi panogami, in sicer predvsem zaradi pomanjkanja **interoperabilnosti**, oziroma pomanjkljive izmenjave ter sodelovanja pri ustvarjanju projektnih informacij, kar naj bi samo v ameriškem gradbeništvu povzročalo 36 milijard dolarjev letnih izgub (McGraw-Hill 2007, str.6). Učinkovitejšo izmenjavo informacij med različnimi deležniki gradbenih projektov naj bi omogočil BIM-pristop (ang. *Building Information Modeling, Building Information Model*) oziroma **informacijsko modeliranje gradenj**. BIM-pristop bom pojasnil in podrobneje opisal v svojem magistrskem delu.

Združenje BuildingSMART, nastalo leta 2006, je zasnovalo odprt IFC standard (ang. *Industry Foundation Classes*), na katerem temelji interoperabilnost oziroma izmenjava podatkov med različnimi računalniškimi programi. To je omogočilo nov pristop k izvajanju in vzdrževanju gradenj. Že v začetni fazi snovanja projekta se vzpostavi integriran računalniški BIM-model, ki omogoča integracijo v 3 dimenzionalen računalniški model časovno in stroškovno komponento, tehnične lastnosti uporabljenih izdelkov, kot tudi druge podatke, ki so lahko pomembni za različne deležnike projekta. Z uporabo COBie standarda omogoča BIM-pristop opremljanje BIM-objektov tudi z informacijami, potrebnimi za upravljanje premoženja, tako prostora kot vgrajene opreme oziroma inventarja. Sodelovanje preko enovitega BIM-modela zagotavlja, da si izvajalci med seboj delijo iste projektne informacije. BIM-pristop s tem omogoča postavljanje terminov izvedb (zaporedje in trajanje aktivnosti), različne ocene pričakovanih stroškov ter dejanskih stroškov gradnje, kot tudi izbor najbolj primernega ponudnika tako s tehničnega kot tudi stroškovnega in terminskega stališča. S tem se lahko predvidi možnosti in omejitve, na katere lahko naletimo pri izvedbi gradbenega projekta, kot tudi pri kasnejšem vzdrževanju gradnje.

Pri uvajanju BIM-pristopa v podjetja in organizacije je vodilno vlogo v svetu prevzela Velika Britanija (v nadaljevanju VB). Leta 2010 je vlada VB začela pripravljati strategijo, ki jo je nato objavila v dokumentu Vladna strategija v gradbeništvu. Po njeni objavi se je začel vzpostavljati celotni podporni program za uvajanje BIM-pristopa v podjetjih, saj je leta 2016 postala njegova uporaba obvezen pogoj za pristop k vsem javnim naročilom. Sočasno od leta 2010 naprej, je združenje NBS (ang. *National Building Society*, v nadaljevanju NBS) izvajalo vsakoletno anketo za britansko vlado, s katero so merili, kako dobro je zasebni sektor pripravljen na vpeljavo BIM-pristopa v javna naročila. Oktobra 2010 je bila izvedena prva anketa, ki je pokazala da 42 % anketirancev CAD programov

sploh ni uporabljalo in je načrte risalo na roko, 43 % BIM-pristopa sploh ni poznalo, samo 13 % pa je BIM-pristop uporabljalo (NBS BIM Report March 2011, str.8). Podobno anketo je NBS izvedel leta 2013 in 2016 mednarodno, z namenom primerjave uveljavitve BIM-pristopa VB z drugimi državami in razjasniti kakšna je prihodnost uveljavitve BIM-pristopa v mednarodnem okolju (NBS International Report 2013, str.3).

Namen magistrskega dela je seznanjanje in spodbujanje uporabe informacijskega modeliranja v Sloveniji, pomagati potencialnim uporabnikom pri odločitvi, ali se odločiti za uporabo informacijskega modeliranja ali ne, ter spodbujanje razmisleka o zakonski obveznosti vpeljave informacijskega modeliranja gradenj v javna naročila po vzoru VB.

V magistrskem delu sem ugotavljal, kako dobro poznajo slovenska podjetja BIM-pristop, koliko je v uporabi, kakšno je mnenje med uporabniki in poznavalci BIM-pristopa ter kako razširjena in razvita je uporaba BIM-pristopa v primerjavi z VB. Zanimalo me je tudi, ali je med uporabniki in poznavalci BIM-pristopa vzpostavljeno prepričanje, da BIM-pristop omogoča večjo kompatibilnost in krepi sodelovanje med različnimi deležniki projekta ter tako prispeva k dvigu produktivnosti kot tudi konkurenčnosti. Da se tako prepričanje sploh lahko vzpostavi pa je nujno potreben celoten ekosistem, ki tak način dela sploh omogoča.

Cilj magistrskega dela je primerjava stanja BIM-pristopa v Sloveniji z VB, kjer naj bi bil najbolj uveljavljen. Analiza naj bi pokazala podobnosti in razlike v delovanju slovenskih in britanskih podjetij ter kritično samooceno, katere ukrepe in spremembe bi slovenska podjetja morala uvesti, če bi želela stopiti na pot BIM-pristopa.

Predstavil sem kritično pregledano tujo in domačo strokovno literaturo, članke in raziskave. Po raziskavi, ki so jo izvedli Carneiro in ostali leta 2012, je Slovenija že v letih 2010 in 2011 po številu akademskih strokovnih člankov na temo BIM-pristopa zasedla deveto mesto na svetu, ki si ga je delila z Norveško in Dansko, najbolj plodna avtorja pa sta bila g. Tomo Cerovšek iz FGG-ja ter Raja R. A. Issa s floridske univerze (Carneiro et. al. 2012, str.5). Kljub temu je BIM-pristop v času nastajanja pričujočega magistrskega dela v splošni javnosti ostal razmeroma neznan ali celo nepoznan. To se je pokazalo tudi pri knjižničnem gradivu, saj za javnost skoraj ni bilo dostopno in je bilo pretežno rezervirano le za profesorje. Kako pa so z BIM-pristopom seznanjena slovenska podjetja, podrobneje prikazuje anketna raziskava, narejena na vzorcu stotih anketirancev.

Zaradi hitrega razvoja BIM-pristopa je ključen tudi pregled spletnih strani in virov vladnih in nevladnih organizacij, ki s postavljanjem priporočil, specifikacij in standardov sooblikujejo delovanje in javno objavljajo relevantne podatke o stanju BIM-pristopa.

V prvem poglavju predstavljam trenutno planiranje in kontrolo projektov z vidika terminov in stroškov glede na tradicionalna pogodbena razmerja, saj le ta bistveno vplivajo na hitrost in kakovost izvedbe gradbenih projektov. V drugem poglavju pojasnjujem delovanje informacijske podpore projektom, njeno zgodovino, oblikovanju informacijski podpori projektivi (kot v gradbeništvu imenujejo tehnično načrtovanje) in kasnejši integraciji

projektive ter stroškovnega in terminskega planiranja. Tretje poglavje je poglavje o BIM-pristopu, v katerem pojasnjujem termine za razumevanje BIM-pristopa. Prav tako v njem predstavim postopek vpeljave BIM-pristopa kot nujni pogoj za vsa javna naročila v VB. V četrtem poglavju predstavljam rezultate empiričnih raziskav, ki jih je izvajal NBS med leti 2011 in 2016 ter jih uporabil za primerjavo z izsledki lastne empirične raziskave. Pri empiričnem vrednotenju raziskovalnih vprašanj si pomagam z metodami opisne statistike, rezultate raziskave pa bom povzel v sklepnem delu.

1 PLANIRANJE IN KONTROLIRANJE PROJEKTOV

Projekt, zlasti gradbeni, je po PMBOK-u definiran kot začasno prizadevanje za uresničitev edinstvenega izdelka, storitve ali rezultata (PMBOK 2008, str.5). Začasnost projekta nam pove, da ima določen začetek in konec aktivnosti, ki je lahko odvisen od zadanega časovnega okvirja. Kot primer edinstvenosti je v PMBOK-u navedeno, da je bilo zgrajeno že na tisoče poslovnih zgradb, vendar je vsaka posamezna zgradba edinstvena, saj imajo te med seboj različne lastnike, lokacije, pogodbenike (PMBOK 2008, str.5). Enkratnost projekta zato zahteva, da projekte pred vsako izvedbo vsakič znova definiramo, zato da bi jih kasneje tudi uspešno realizirali. Spletni slovar Fran pa definira projekt kot sklop aktivnosti, kaj se misli narediti in kako naj se to uresniči ali projekt kot tehnična dokumentacija, skupek načrtov, tehničnih opisov in popis stroškov (Fran b.l.).

Hauc deli projekte na *stohastične*, katerih končni cilji niso povsem znani in *determinirane*, pri katerih je mogoče zaradi jasnosti cilja določiti izvedbo že v naprej. Gradbeni projekti tako spadajo med determinirane projekte, pri katerih se na podlagi vhodne strategije ali projektnega naročila že v pripravi zagona projekta določijo namenski in objektni cilji ter na tej podlagi izdelata celovit plan in organizacija izvedbe, po katerem se projekt nato izvede in je verjetnost izvedbe projekta po planu tudi zelo velika (Hauc 2007, str.79).

Za zagotovitev učinkovite izvedbe projekta je potrebno vzpostaviti management projekta. Stare ugotavlja, da je med različnimi avtorji **projektni management** najpogosteje deljen na 4 faze (Stare 2011, str.38):

- *planiranje*, je predvidevanje prihodnosti in ocena njenega vpliva na združbo, opredeljevanje ciljev in poti za njihovo doseganje, ter razvoj pravil in postopkov;
- *organiziranje* določa medsebojna razmerja ljudi, ki bodo omogočili izvedbo plana - kadrovanje izvajalcev, vzpostavitev oddelkov, delegiranje in prenos pristojnosti na nižje ravni, vzpostavitev verige ukazovanja ter koordiniranje dela podrejenih;
- *vodenje* je vplivanje, motiviranje in usmerjanje zaposlenih, da bi ustrezno opravili naloge, ki so jim bile dodeljene s planom in organizacijo - navduševanje ljudi za naporno delo, vzdrževanje morale, skrb za kulturo združbe, obvladovanje nesporazumov, sporov in komunikacij;
- *kontroliranje* vključuje spremljanje doseženega in ukrepanje v primeru odstopanja izvedbe od plana.

Velja okvirna delitev, v kateri *faza priprave* projekta vključuje *planiranje in organiziranje*, *faza izvedbe* pa *vodenje in kontroliranje* (Stare 2011, str.43). Za potrebe magistrske naloge se bom osredotočil predvsem na planiranje in kontroliranje projektov z vidika časa (terminov) in stroškov projekta, saj sta ti dve komponenti trenutno bistveni, ko je govora o razlogih za uvajanje BIM-pristopa v gradbeništvu.

1.1 Planiranje in kontroliranje časa

Planiranje terminskega plana projekta se po mnenju mnogih avtorjev običajno prične s členitvijo projekta in izdelavo seznama vseh aktivnosti, ki jo nato prikažemo v *strukturi del oziroma aktivnosti* ali *WBS diagramu* (ang. *work breakdown structure*, v nadaljevanju WBS). Pred začetkom členitve projekta je potrebno skupaj z naročnikom določiti pričakovan obseg, terminske in stroškovne omejitve, izdelek projekta, ki se lahko prikaže s *PBS* (ang. *product breakdown structure*, v nadaljevanju PBS), specifikacije izdelka ter plan za obvladovanje sprememb. Značilnost gradbenih projektov je, da imamo tri tipične udeležence - naročnika, projektanta in gradbenika, pri čemer je vhodni PBS za gradbeno podjetje načrt (v obliki 2D in 3D risb), ki ga pripravi projektant. Sledi členitev projekta, kjer različni avtorji navajajo dve različni izhodišči. *Vsebinska členitev* temelji na strukturirani členitvi samih proizvodov, posamezno navedenim podsestavom pa dodamo le glagolnik in dobimo aktivnost v WBS-u; ter *fazna členitev*, kjer navajamo zaporedja faz projekta in nam PBS služi samo kot podlaga za členitev faz oziroma aktivnosti. WBS diagram je običajno podoben organigramu, delo oziroma aktivnosti pa je mogoče členiti samo glede na besedilo, v enem stolpcu ali z zamiki alinej, za večjo preglednost pa se posameznim ravnem podpišejo ustrezne številke. Haugan pravi, da je pri kreiranju WBS-a osnova pravilo 100 %, ki pravi, da mora vsak naslednji nivo razgradnje WBS elementa, to je nivo otroka, zajemati 100 % aktivnosti, ki so potrebne za doseg naslednjega višjega nivoja elementa, to je starša (Haugan 2002, str.17). Kot pravi Burek iz PMI (ang. *Project management institute - PMI*) služi WBS diagram kot osnova, na podlagi katerega deležniki projekta nato izdelajo mrežni in terminski plan, gantogram, plan virov in stroškov ter služi za sprejemanje odločitev v primeru nepričakovanega širjenja obsega projekta (Burek 2013).

Sledi **ocenjevanje trajanje aktivnosti**, kjer naj bi po PMBOK-u pridobivali informacije o trajanju aktivnosti od oseb ali skupine v projektnem timu, ki je najbolje seznanjena z naravo vsebine dela v konkretni planirani aktivnosti ter tako zagotoviti čim bolj objektivne opredelitve termina in trajanja aktivnosti (PMBOK 2008, str.139). Stare pa poleg tega omenja, da si v projektno razvitejših združbah lahko pomagajo s plani in poročili o izvedbi podobnih projektov ter s statističnimi normativi dobljenimi z analizo končanih projektov (Stare 2011, str118).

Z združitvijo trajanja posameznih aktivnosti in ocene o možnem vzporednem izvajanju posameznih aktivnosti nastane *mrežni plan*, ki nam služi za oceno *kritične poti* oziroma

CPM (ang. *critical path method*, v nadaljevanju CPM). Z njim določimo katere so tiste aktivnosti, ki potrebujejo dodatno kontrolo pri izvajanju, saj so ključne za doseganje zaključka projekta v zadanem roku ter dodaten premislek o izvedbi, in sicer kakšne so možnosti za skrajšanje izvedbe (ang. *crashing*), saj bi si lahko tako ustvarili časovno rezervo. Aktivnosti, ki niso na kritični poti projekta, pa imajo časovne rezerve, tako da se lahko izvedejo najpozneje do začetka prve kritične aktivnosti, ki jim sledi.

Gantogram (ang. *Gantt chart*) ali *terminski plan* je zaradi jasne predstave o poteku projekta in zajemu vseh možnosti pri ustvarjanju časovnih rezerv, danes med najbolj priljubljenimi orodji za planiranje in kontrolo projektov. V uporabi je od leta 1917 in v začetku ni vključeval povezav med posameznimi aktivnostmi, kar je bila glavna pomanjkljivost v primerjavi z mrežnim planiranjem. Poleg tega pa je zahtevalo spreminjanje in posodabljanje gantograma veliko truda in časa, če je prihajalo do sprememb planiranih aktivnosti na kompleksnih projektih. Danes je gantogram ponovno v vzponu, zahvaljujoč uporabi sodobnih računalniških orodij, ki omogočajo hitro kreiranje, posodobitev in printanje gantogramov, glavna prednost gantogramov v primerjavi z mrežnimi diagrami pa je jasen prikaz trajanja posamezne aktivnosti, obenem pa lahko prikazuje dodatne informacije, kot so korelacije med posameznimi aktivnostmi in s tem določitev kritične poti, napredovanje posamezne aktivnosti ali faz projekta, poraba virov v posamezni aktivnosti idr. (Gantt.com 2018). Gantogram poleg krajšanja kritičnih aktivnosti omogoča tudi ustvarjanje časovnih rezerv s prekrivanjem aktivnosti (ang. *fast tracking*), kar pomeni, da začnemo z izvedbo naslednje povezane aktivnosti predčasno in tako obe povezani aktivnosti potekata nekaj časa sočasno oziroma vzporedno. Prav tako pa je možno skrajšati aktivnosti z izbiro zunanjih ali določitvi dodatnih izvajalcev za posamezne aktivnosti.

Izdelavi terminskega plana sledi *planiranje virov*, ki je tudi v tesni povezavi s planiranjem stroškov. Po Heldmanu je planiranje virov proces določanja kakšni viri – ljudi, oprema in finančna sredstva - in v kakšni količini so potrebni za izvedbo načrtovanih projektnih aktivnosti, saj kot dodaja Kerzner, raven usposobljenosti zaposlenih, kakovosti materialov in druga potrebna oprema vplivajo tako na planiranje virov, kot tudi terminov in stroškov, poleg tega pa se omejijo tveganja, ki lahko izhajajo iz pomanjkljivega planiranja virov (Heldman 2002, str.196; Kerzner 2001, str.1205). Če vnesemo stroške v gantogram, dobimo plan potrebnih finančnih sredstev v posameznih časovnih obdobjih, prav tako pa lahko vnesemo tudi druge potrebne vire za posamezno aktivnost in s tem določimo kdaj naj bodo posamezni viri na voljo za izvedbo aktivnosti. Oceno potrebnih virov projekta pa lahko dobimo tudi z uporabo WBS-a, kjer v vsako aktivnost vnesemo potrebne vire. Po PMBOK-u je pri planiranju virov pomembno tudi izravnavanje obremenitev (ang. *resource leveling*), saj lahko vpliva na začetno ocenjeno kritično pot. Pri tem želimo enakomerno in objektivno obremeniti redke vire in jih prerazporejamo iz nekritičnih na kritične aktivnosti (PMBOK 2008, str.146). Avtorja Rozman in Stare (2008, str.100) omenjata dva mejna pogoja, in sicer omejeno število ljudi, kjer se trajanje in razpored aktivnosti prilagodi razpoložljivemu kadru ali pa je projekt časovno omejen**,** zaradi česar moramo imeti dovolj

kadra na razpolago, v primeru pomanjkanja pa najamemo zunanjega izvajalca, da bi projekt izvedli v zadanem roku.

V splošnem avtorji navajajo pri *kontroliranju skladnosti izvedbe s terminskim planom* štiri korake, in sicer ugotavljanje trenutnega stanja izvedbe, primerjavo trenutnega stanja z načrtovanim terminskim planom oziroma gantogramom, ugotavljanje sprememb oziroma odstopanj od terminskega plana ter korektivni ukrepi s katerimi želimo doseči izpolnitev zastavljenih ciljev oziroma omejiti zaostanek. Z zgodnjim odkrivanjem odstopanj se lahko hitreje odzovemo na vzroke, ki povzročajo zamujanje projekta in uporabimo tehnike namenjene odpravljanju zaostanka, kot so krizna akcija, skrajšanje izvedbe ali s prekrivanjem aktivnosti. Najpogosteje se napredovanje aktivnosti, ki jih dobimo s kontroliranjem, vnaša direktno v gantogram, kjer se senči posamezna aktivnost ali pa se skozi posamezno aktivnost nariše linija glede na trenutno stanje. Tako se takoj opazi zaostajanje aktivnosti, še posebno pozornost pa se namenja aktivnostim, ki so na kritični poti. Klein je mnenja, da je *linija stanja* (ang. *progress Gantt chart, Jogging line*) najpogostejši način kontrole terminskega plana (Klein 1999, str.56). *B-C-F analiza* (ang. *Baseline-Current-Future*) je podobna liniji stanja, le da se tu vzporedno vrišejo planirano, trenutno in predvideno trajanje posamezne aktivnosti. B-C-F analiza nam tako posreduje informacijo o morebitnem zaostajanju posamezne aktivnosti, predvsem pa koliko bodo, v primeru da ne sprejmemo nobenih korektivnih ukrepov, zaradi tega zamujale tudi sledeče si aktivnosti do konca projekta. Glavna prednost B-C-F analize naj bi bila po Miloševiču enostavnost uporabe orodja, s katerim dosežemo glavni cilj projektnega managementa, to je predvidevanje poteka projekta (Miloševič 2003, str.394).

1.2 Planiranje in kontroliranje stroškov

Po PMBOK-u je planiranje stroškov združevanje ocenjenih stroškov posameznih planiranih aktivnosti, da pripravimo skupno osnovo stroškov, s katerimi merimo dosežke projekta (PMBOK 2008, str.167). PMBOK deli obvladovanje stroškov na tri procese, in sicer **ocenjevanje, planiranje in kontroliranje stroškov** (PMBOK 2008, str.157).

Okvirna ocena stroškov se izračuna na podlagi preteklih primerljivih projektov in aktivnosti, zato pri kasnejši podrobnejši oceni stroškov prihaja do odklonov, ki stroške projekta podražijo ali pocenijo, s tem pa vplivajo na odločitev, ali se bo projekt sploh izpeljal oziroma ali pa naj se poveča proračun projekta, če naročnik oceni, da so popravljeni finančni kazalniki zanj še vedno sprejemljivi. Sledi *podrobna ocena stroškov projekta* kjer terminski plan in plan virov služita kot osnova za izdelavo, saj lahko plan virov predelamo v plan stroškov tako, da predvidene količine pomnožimo s ceno, poleg pa upoštevamo še posredne stroške ljudi. Podrobna ocena stroškov in časovni plan stroškov projekta sta namenjena preverjanju okvirne ocene stroškov, ki je bila izdelana v fazi snovanja, posledično pa tudi popravku vrednosti projekta, preverjanju finančnih kazalnikov, dokončnemu dogovoru o proračunu projekta, kontroliranju stroškov v fazi izvedbe ter pripravi plana financiranja projekta (Stare 2011, str.127).

Kerzner pravi, da ima vsako podjetje svoj pristop k *ocenjevanju stroškov*, vendar lahko za začetno usmeritev delimo tehnike ocenjevanja stroškov na tri pristope (Kerzner 2009, str.574). *Analogno ocenjevanje* temelji na izkušnjah in stroških predhodnih podobnih, že izvedenih projektov. Oceno se prilagaja glede na obseg in zahtevnost projekta ter poteka v WBS-u od zgoraj navzdol (ang. *top-down*), torej se oceni celotni projekt ali pa samo večji sklopi posameznih aktivnosti. Ker je ocena najmanj zanesljiva od ostalih metod, a je hitra in z nizkimi stroški priprave, se jo uporablja le za odločitev o smotrnosti izvedbe projekta. *Parametrično ocenjevanje* uporablja matematične modele, ki upoštevajo statistične vrednosti posameznih, izbranih parametrov projekta, ki temeljijo tako na preteklih izkušnjah kot stroških posameznih virov in poteka po WBS-u od zgoraj navzdol. Ta tehnika se, tako menita tako Stare kot Kerzner, najpogosteje uporablja predvsem pri gradbenih projektih. Prednost te tehnike je ponovno hitrost, a je zaradi majhne natančnosti uporabna samo za predhodno oceno projekta. Sledi najnatančnejša tehnika, inženirska ocena, s katero se podrobno ocenijo vsi stroški posameznih aktivnosti, od najnižje ravni WBS-a navzgor (ang. *bottom-up*). Ocena temelji na natančno ocenjenih stroških vseh aktivnosti, potrebnih virov in stroških tako virov kot zunanjih izvajalcev, zato je zanjo potrebno največ časa in stroškov za pripravo. Njena glavna prednost je, da nam zaradi natančnosti, v povezavi z gantogramom, služi za kontroliranje stroškov med izvedbo projekta. Kerzner pravi, da mnogo podjetij skuša postopke ocenjevanja stroškov standardizirati s kreiranjem ocenjevalnih priročnikov, ki lahko zmanjšajo stroške priprave ocene tudi za 90 % (Kerzner 2009, str.574). Podobno predlaga tudi Stare, ki meni, da je smotrno pripraviti referenčne modele projektov, če se v združbi izvaja veliko podobnih projektov, ki vključujejo terminski plan aktivnosti ter potrebe in stroške virov, saj se lahko s prilagoditvijo zahtevam novega projekta dokaj hitro pripravi zelo realen plan stroškov (Stare 2011, str.130).

Drugi korak je *planiranje stroškov*, kjer združimo skupaj oceno stroškov posameznih aktivnosti s terminskim planom posameznih aktivnosti. Z njim merimo dosežke projekta in kontroliramo stroške posameznih aktivnosti. PMBOK navaja, da ocene stroškov za planirane aktivnosti združimo, skladno z WBS, od spodnjih ravni delovnih paketov do komponent višjih ravni, kot so na primer kontrolni konti, vse do končnih stroškov celotnega projekta (PMBOK 2008, str.169). Lester pravi, da nam plan stroškov omogoča že na začetku projekta oblikovati dokaj natančno sliko poteka finančnih izdatkov in če poteka projekt po terminskem planu, se lahko izračuna potreben denarni tok, pri tem pa je potrebno upoštevati različna obdobja nastanka stroškov (Lester 2003, str.211). To nam omogočajo sodobna računalniška orodja, v katera najprej vnesemo podatke o planiranih stroških za vsako aktivnost in kasneje tudi dejanske stroške, ko ti nastanejo. Podatki o skupnih zneskih planiranih in dejansko nastalih stroškov so vseskozi posodobljeni, tako da nam omogočajo kontrolo stroškov skozi celotno izvedbo projekta (Kerzner 2003, str484). V terminskem planu stroškov projekta so tako planirani začetni in končni datumi za planirane aktivnosti projekta, planirani mejniki, delovni in planski paketi in kontrolni

konti, te informacije pa so potrebne zaradi združevanja stroškov po koledarskih obdobjih, ko naj bi stroški po planu nastali (PMBOK 2008, str.168). Graf je sestavljen iz časovnih obdobij na abscisni in višine stroškov na ordinatni osi, v graf pa se vriše planirane kumulativne stroške, ki s povezavo posameznih točk dobijo zvezno obliko črke S. Graf služi kot osnova za pripravo načrta financiranja projekta, ki zajema tudi določitev finančnih rezerv za potrebe sprememb, ki lahko nastanejo med izvedbo projekta. Financiranje se zaradi intervalne narave vnaša v graf kot stopničasta krivulja.

Tretji korak, *kontroliranje stroškov*, se običajno izvaja z analizo prislužene vrednosti EVA (ang. *earned value analysis,* v nadaljevanju EVA), sinonimi zanjo pa so tudi tehnika prislužene vrednosti EVT (ang. *earned value technique* - *EVT*), metoda prislužene vrednosti EVM (ang. *earned value management* - *EVM*) in sistem za celovito obvladovanje prislužene vrednosti EVMS (ang. *earned value management system* - *EVMS*). Kot pravi Cullen odgovarja EVA analiza na dvoje ključnih vprašanj, in sicer ali bo končni strošek projekta manjši, večji ali enak predvidenim stroškom, ter ali bo projekt zaključen v postavljenem roku (Cullen 2016).

V terminski plan stroškov se vnaša sledeče tri S-krivulje:

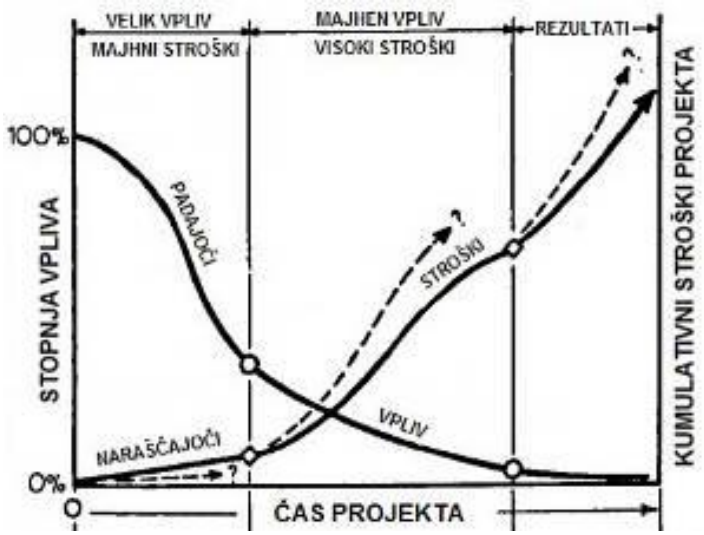
- **BCWS** (ang. *budgeted cost of work scheduled,* v nadaljevanju BCWS) ali **PV** (ang. *planned value* - *PV*), to je planirani strošek, načrtovan pred izvedbo projekta,
- **ACWP** (ang. *actual cost of work performed,* v nadaljevanju ACWP) ali **AC** (ang. *actual cost* - *AC*), ponazarja dejanski strošek opravljenega dela,
- **BCWP** (ang. *budgeted cost of work performed,* v nadaljevanju BCWP) ali **EV** (ang. *earned value* - EV) pa predstavlja vsoto planiranih stroškov za že opravljeno delo.

Razlika med planiranimi stroški BCWP in planiranimi stroški za že opravljena dela BCWS prikazuje terminsko odstopanje oz. zamujanje projekta, razlika med planiranimi stroški BCWP in dejanskimi strošek opravljenega dela ACWP pa stroškovno odstopanje oz. preveč porabljenega denarja.

Sledi raziskovanje vzrokov za nastala odstopanja, saj ta vplivajo na končni strošek celotnega projekta. Pomembno je ugotoviti prave vzroke odstopanj, saj lahko samo tako sprejmemo primerne ukrepe za njihovo odpravo. Obstajajo različni vzroki za odstopanja, najpogostejši vzrok pa naj bi bilo plačevanja računov pogodbenim izvajalcem, zato Stare za boljši pregled nad stroški priporoča izris več diagramov, ki temeljijo na posamezni vrsti stroška (Stare 2011, str.260).

Paulson je leta 1976 narisal diagram prikazan na Sliki 1, v katerem je ponazorjeno obratno razmerje med stopnjo vpliva in stroški sprememb, kjer vpliv na spremembe skozi faze projekta pada, stroški sprememb pa naraščajo (Paulson 1976, str.588).

Slika 1: Paulsonova krivulja



Vir: Davis 2018.

2 INFORMACIJSKA PODPORA PROJEKTOM

Razvoj informacijsko komunikacijske tehnologije (v nadaljevanju IKT) je omogočil instantno diseminacijo informacij, ne glede na fizično razdaljo. Z naraščanjem števila in kompleksnosti projektov v organizaciji, je postala informacijska podpora projektom nujno potrebna, če se želi ohraniti zmožnost učinkovitega upravljanja projektov. Kot pravi Kerzner, je komunikacija več kot samo predajanje sporočil – je vir kontrole, zato je nujno potrebno zagotoviti, da se prava informacija najde na pravem mestu ob pravem času, če se želimo izogniti problemu babilonskega stolpa (Kerzner 2009, str.238).

Informacijska podpora projektom je v PMBOK-u zajeta v poglavju **planiranje komunikacij**, s katerimi določimo informacijske in komunikacijske potrebe udeležencev projekta ter primernih načinov in sredstev za zadovoljitev teh potreb. Plan komunikacij je potrebno pripraviti v najzgodnejših fazah projekta, ga skozi izvedbo projekta preverjati in po potrebi spreminjati, da bi zagotovili neprekinjeno uporabnost, pri tem pa je potrebno upoštevati organizacijsko strukturo organizacije, ki projekt izvaja, oziroma njen organigram, saj ta močno vpliva na oblikovanje plana (PMBOK 2008, str.225). S tem se posredno vpliva na izbiro in vzpostavitev računalniško podprtega projektnega informacijskega sistema (ang. *project management information system*, v nadaljevanju PMIS), ki naj bi bil prilagojen potrebam posamezne organizacije.

Prav tako pa je potrebno predstaviti revolucijo, ki jo je prineslo računalniško podprto konstruiranje (ang. *computer aided design*, v nadaljevanju CAD) na področje načrtovanja gradenj in programov za projektni management, ki so omogočili izvedbo izjemno kompleksnih projektov z omejenimi predvidenimi sredstvi in času.

2.1 Zgodovina informacijske podpore

Zgodovina informacijske podpore je tesno vezana z razvojem dveh vej, in sicer **razvojem teorij o sistematični delitvi in opredelitvi povezav med delovnimi procesi**, kar je omogočilo sistematično in avtomatizirano obdelavo informacij ter **razvoj IKT tehnologij** kot orodja, s katerim je možno obvladovanje kompleksnosti povezav in obdelovanje velikih količin podatkov ter operacij, ki so potrebne za učinkovito management današnjih projektov.

Azzopardi deli razvoj modernega projektnega managementa na 4 obdobja, in sicer prvo pred letom 1958, drugo med letoma 1958 in 1979, tretjo med leti 1980 in 1994 ter četrto po letu 1994 (Azzopardi b.l.). Azzopadijeva delitev temelji predvsem na razvoju tehnologije in orodij, ki posledično spreminjajo tudi projektni management. Podobno delitev ima tudi Kerzner, ki temelji na razvoju orodij in teorij projektnega mangementa (Kerzner 2009, str.38). Obe delitvi se med seboj prekrivata v obdobjih, saj sta v vzajemnem odnosu – razvoj novih tehnologij in procesov je prispeval k razvoju novih orodij projektnega managementa, nova orodja projektnega managementa pa so prispevala k hitrejšemu in boljšemu razvoju novih tehnologij in procesov.

Prvo obdobje imenuje Azzopardi od obrtnega sistema do človeških odnosov, ki ga poganja razvoj transporta in telekomunikacij. Utemeljitelj strukturirane delitve del je poljski ekonomist in inženir Karol Adamiecki, ki je leta 1896 postavil prvo vizualno delitev medsebojno povezanih procesov za določitev trajanja posameznih procesov, imenovan harmonogram. Urwick ocenjuje, da se je zaradi uporabe harmonograma, produktivnost v železarnah, kovinski industriji, kmetijstvu in rudarstvu povečala od 100 % do 400 % (Urwick 1956, str.108). Harmonogram velja kot temelj za razvoj gantograma, ki pa je imel dve slabosti, in sicer že omenjeno pomanjkanje povezav med posameznimi aktivnostmi in s tem določanje kritične poti ter ročno popravljanje celotnega gantograma, če je prišlo do sprememb v trajanju aktivnosti in s tem podaljšanje ali krajšanje termina, kar je bilo zelo zamudno in zahtevno opravilo, še posebno, če je bil gantogram kompleksen. Poleg gantograma je razširjena uporaba delovnih specifikacij, ki se je v naslednjem obdobju kasneje razvila v WBS diagram. V tem obdobju so z uporabo teh orodij nastala Pacifiška železnica v 1850-ih, hidroelektrični Hooverjev jez, pri katerem je sodelovalo 5.200 delavcev, zgrajen med leti 1931 in 1936 in dokončan 2 leti pred rokom ter Projekt Manhattan, kjer je pri razvoju atomske bombe med leti 1942 in 1945 sodelovalo 125.000 delavcev.

Sledi *drugo obdobje* med letoma 1958 in 1979, imenovana aplikacija znanosti managementa. V tem obdobju je silovit razvoj tehnologij doprinesel k pojavu mrežnih diagramov in planiranja. Podjetje Du Pont je pri načrtovanju gradenj kemičnih tovarn razvilo puščični mrežni diagram s kritično potjo CPM, za planiranje in kontrolo projektnih aktivnosti. Ker so bile aktivnosti in stroški zaradi ponavljanja gradenj že znane, se jih je lahko predvidelo tako po trajanju kot stroških. Nasprotno pa ameriška mornarica pri

razvoju podmorniškega raketnega sistema Polaris v 50-ih letih, ni poznala ne terminov ne stroškov projekta, zato je razvila puščični mrežni diagram PERT (ang. *program* (*or project*) *evaluation and review technique*, v nadaljevanju PERT), kjer se s statističnimi metodami skuša oceniti najkrajše trajanje za posamezno opredeljene aktivnosti ter celotnega projekta (Surbhi 2015). Sredi 70-ih se pojavijo prvi osebni računalniki, leta 1977 pa se na tržišče plasirata prva programa namenjena projektnemu managementu, Artemis, ki je bil namenjen načrtovanju, planiranju in kontroli terminov ter stroškov in management virov projektov ter Oracle, namenjen ustvarjanju baz podatkov.

Tretje obdobje med letoma 1980 in 1994 je imenovan proizvodni center so človeški viri.
S pocenitvijo osebnih računalnikov in razvojem računalniške komunikacije je prinesel do revolucije na področju informacijskega managementa. IKT tehnologija je odpravila vse predhodne pomanjkljivosti gantograma. Klein je leta 1999 ugotovil, da je gantogram postal najbolj razširjeno orodje projektnega managementa za planiranje in kontrolo časa (Klein 1999, str.49). Azzopardi izpostavlja med drugim prireditev zimskih olimpijskih iger leta 1988 v Calgaryu, kjer se orodja projektnega managementa uporabijo za organizacijo prireditve ter projekt Space Shuttle, kjer nesreča raketoplana Challenger privede do razvoja managementa tveganj, skupinske dinamike in managementa kakovosti. Tehnologija v veliki meri ni več omejitev, temveč so ključni postali usposobljeni človeški viri.

Četrto obdobje je obdobje po letu 1994 in je imenovan ustvarjanje novega okolja. Glavno gonilo razvoja v tem obdobju je internet, ki je svet integriral v eno celoto, oblikoval informacijsko družbo in sprožil procese globalizacije. Izjemno hitra in povsod dostopna komunikacija, je z uporabo sodobnih informacijskih orodij dvignila produktivnost in učinkovitost proizvodnih procesov. Večina programov za projektni management ima možnost sodelovanja preko interneta, tako da se podatki v projektno informacijskem sistemu posodabljajo v realnem času in omogočajo takojšno kontrolo, analizo ter odziv na dogajanja v procesih.

2.2 Informacijska podpora projektivi

Splošna uveljavitev in dostopnost računalniških sistemov, je omogočila izvajanje učinkovite podpore projektive v dveh segmentih:

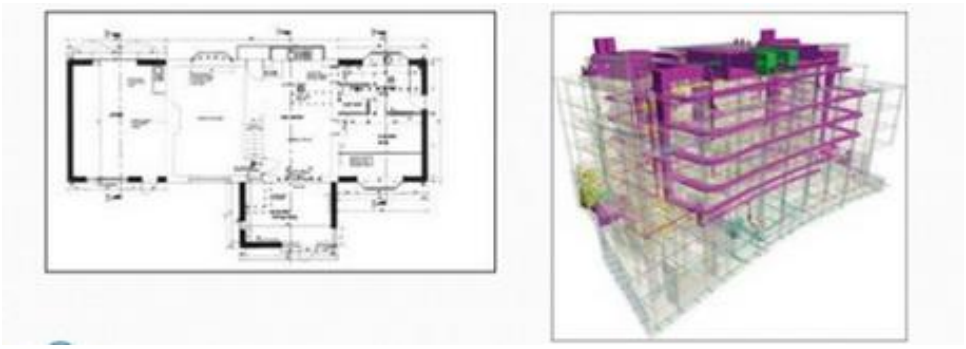
- kot **orodje za izdelavo računalniških modelov gradenj;** z uporabo CAD programov se je začelo obdobje gradbene informatike;
- kot **komunikacijsko orodje,** ki omogoča učinkovito deljenje in shranjevanje projektnih informacij z uporabo projektno informacijskega sistema.

Tehnična dokumentacija se do 60-ih let 20. stoletja ni bistveno spreminjala, z nastopom digitalne tehnologije pa se je pričel razvoj tudi na tem področju, ko so se za prenos ročno risane tehnične dokumentacije v računalnike začeli uporabljati digitalizatorji. Z njimi si je

cenilec pomagal pri kvantifikaciji objektov, kot so zidovi, nadstropja in stropi, število oken, vrat in opreme, sočasno pa je preverjal, če celotna dokumentacija, ki jo je pripravil arhitekt za gradbenega izvajalca, prikazuje zvezno sliko in je izvedljiva. Pri tem je realnost ocene stroškov bila zelo odvisna od sposobnosti in izkušenj cenilca (Hardin, chp.1/str.9).

Leta 1957 je Hanratty, zaposlen v ameriškem podjetju General Electric razvil PRONTO (ang. *Program for Numerical Tooling Operations - PRONTO*), prvi komercialni CNC program (ang. *computer numerical control – CNC*), leta kasneje pa je Sutherland na MIT-u zagovarjal doktorsko teza pod naslovom "Sketchpad, Človek-Stroj grafični komunikacijski sistem" (ang. *Sketchpad, A Man-Machine Graphical Communication System*). Med njegovimi posebnostmi je prvi grafični uporabniški vmesnik, ki je omogočal uporabo svetlobnega svinčnika za manipulacijo objektov, prikazanih na CRT monitorju. V 70-ih je sledila splošna uporaba prvih 2D programov, razvoj pa se je usmeril v 3D CAD programe. Versprille je izumil NURBS (ang. *Non Uniform Rational Basis Spline - NURBS*) oziroma »neenakomerno racionalno osnovno krivuljo«, ki je osnova za modeliranje 3D krivulj in površin, Grayer, Lang in Braid pa so razvili PADL (ang. *part and assembly description language - PADL*) modelirnik trdnih teles in njihovih sklopov. V 80-ih letih so se pojavile prvi UNIX delovne postaje s komercialnimi CAD programi, katerih so se zaradi visoke cene posluževali predvsem letalska, avtomobilska in druge industrije. Šele s predstavitvijo osebnega računalnika IBM PC leta 1981 in AUTOCAD programa z uporabo DWG formata za zapis risb, leta 1983, se je pričela splošna implementacija CAD-pristopa (Cohn 2010). Leta 1985 sta Pratt in Wilson prva predlagala koncept dizajniranja z gradniki (ang. *feature*), leta 1987 pa je Geisberg iznašel parametrično modeliranje in plasiral prvi program, ki je uporabljal tudi parametrične gradnike. V poznih osemdesetih in zgodnjih devetdesetih letih je večina razvijalcev CAD programov začela implementirati modeliranje z gradniki in parametrično modeliranje v svoje CAD programe, CAD program Pro-Engineer podjetja PTC pa se šteje za enega prvih programov, ki uporablja tako modeliranje z gradniki kot parametrično modeliranje (Mazen 2015). V 90-ih so postali osebni računalniki dovolj zmogljivi, da so lahko računsko obdelovali ogromne količine podatkov, ki jih generirajo 3D CAD modeli in se začne obdobje simulacij statičnih in dinamičnih, termičnih ter drugih obremenitev. Na Sliki 2 se lahko vidi razkorak med nazornostjo prikaza objekta v 2D tehnični risbi in 3D modelu:

Slika 2: 2D tehnična risba in 3D model



Vir: HajBakri 2017.

2.3 Stroškovno / terminsko planiranje

Razvoj IKT tehnologije je omogočil tudi razvoj programskih orodij za projektni management, ki se v začetku usmerili predvsem v orodja za planiranje in kontroliranje projektov (Stare, str.304). Le-ti so omogočili stroškovno in terminsko planiranje še tako zahtevnih in kompleksnih projektov ter odpravili pomanjkljivosti gantogramov. Na spletni strani Project-Management Zone, je glede na popularnost razvrščenih 225 programov, namenjenih samo projektnemu načrtovanju. Nemec-Pečjak je leta 2009 napravil analizo funkcionalnosti več kot 100 informacijskih sistemov za projektno vodenje in jih po funkcionalnosti razdelil v naslednje sklope (Nemec-Pečjak b.l.):

- podpora skupinskemu delu (ang. *collaborative software*),
- sistem sledenja problemom (ang. *issue tracking system*),
- terminiranje (ang. *scheduling*),
- obvladovanje nabora projektov (ang. *project portfolio management*),
- obvladovanje virov (ang. *resource management*),
- obvladovanje dokumentacije (ang. *document management*),
- spletna aplikacija (ang. *web-based*).

A kot meni Young je kljub temu večina programov za projektni management zasnovana okoli enakih temeljnih značilnostih, ki vključujejo (Young 2007, str.265):

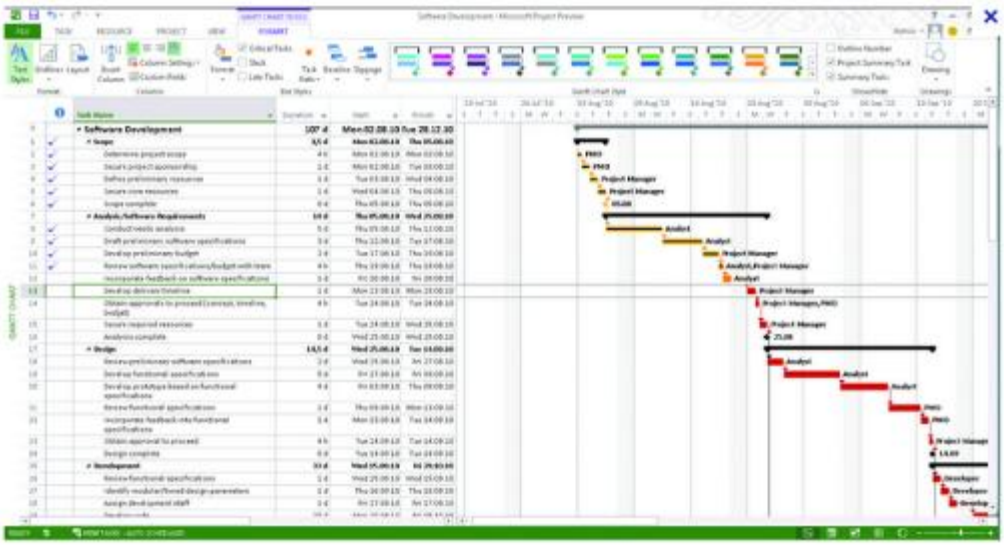
- izdelava seznama aktivnosti na različnih ravneh WBS, vnos o trajanju, zaporedju in medsebojnih odvisnostih aktivnosti;
- izračunavanje kritične poti in časovnih rezerv;
- izdelava gantograma in mrežnega diagrama (CPM ali PERT);
- vnos seznama virov in dodeljevanje virov glede na odgovornost ali zmogljivost;
- vnos podatkov o stroških virov in materiala;
- izdelava proračunskih in stroškovnih krivulj, izračunavanje prislužene vrednosti;
- načrtovanje projekta na podlagi vhodnih podatkov;
- "kaj-če" analiza z uporabo gantograma;
- ugotavljanje in odpravljanje preobremenjenosti virov s prerazporeditvijo virov;
- širok nabor predstavitvenih poročil in možnost izvoza podatkov (običajno v XML formatu).

Ker je za BIM-pristop pomemben predvsem stroškovno in terminsko planiranje, se bom pri mojem magistrskem delu omejil predvsem na prednosti in omejitve pri stroškovnemu in terminskemu planiranju na programu Microsoft Project, saj je ta že dolgo časa najbolj razširjeno orodje za projektni management. Levin je že leta 1998 v svoji knjigi pokomentiral, da je zaradi brezplačne vključitve MS Projecta v paket pisarniških orodij Office, kljub omejitvam programa, dosegel tako veliko popularnost, da je bil avtor prisiljen zaradi obsega knjige izpustiti predstavitve drugih, boljših programov (Lester 2003, str.xii).

Danes je možno izbirati med različnimi storitvami, ki so prilagojene glede na potrebe uporabnika. Tako lahko izbiramo med standardno in profesionalno različico, ki ima dodanih več funkcij, kot npr. orodja za timsko sodelovanje in sposobnost povezave z Microsoft Project Server programom, ki je namenjen shranjevanju projektnih informacij v centralno bazo podatkov, ki je lahko dostopna tudi preko spletnega vmesnika. Microsoft pa poleg namizne verzije programa, ki se namesti lokalno na računalnik, nudi možnost zakupa uporabe storitev v oblaku.

Microsoft Office Project torej shranjuje, povezuje in predstavlja aktivnosti medsebojno povezane v smiselno celoto, na podlagi baze podatkov. Z njim lahko načrtujemo in nadzorujemo trajanje aktivnosti, nastajanje stroškov in obremenjenost virov. Z izvajanjem analiz tveganj lahko hitro razvijamo različne projektne načrte, spremljamo potek projekta, razporejamo in analiziramo obremenjenost virov na posameznih aktivnostih ter tako obvladujemo projektni proračun. Na Sliki 3 je prikazan gantogram, ki ga dobimo iz MS Project-a.

Slika 3: Gantogram iz MS Project-a



Vir: O'Loughlin 2018.

Za nadzor in kontrolo poteka projekta so v modelih MS Project-a določena sledeča štiri stanja:

- prvotno načrtovano stanje (ang. *baseline*),
- dejansko izvršeno stanje (ang. *actual*),
- zadnje stanje z napovedjo novih rokov (ang. *re-scheduled*),
- izvršeno (ang. *remaining*).

Kontrola stanja temelji na zasledovanju:

- dejanskih začetkov in zaključkov izvajanja aktivnosti ter oceni delež izvedenega dela na posameznih aktivnosti v procentih,
- dejanski potroški virov,
- dejanski stroški že izvršenih aktivnosti.

Tako lahko poda napoved, kakšna bodo zamujanja aktivnosti in zaključek projekta, če se pri odstopanjih od načrtovanih ciljev ne odzovemo pravočasno, poleg tega pa omogoča časovno opozarjanje na vgrajeni uri in koledarju (Nemec Pečjak 2010, str.192,193).

2.4 Integrirana podpora projektivi in stroškovno terminsko planiranje

Razvoj integrirane podpore projektivi je omogočil tudi razvoj pogodbenih razmerij, ki so se skozi čas razvijala od zaporednih procesov planiranja v naročniškem pristopu, k vedno bolj vzporednim, do popolnoma vzporedne, integrirane izvedbe projektov, ki jo omogoča BIM-pristop.

Hardin pravi da se pri **naročniškem pristopu** informacije pogosto ne delijo z izvajalcem gradbenih del, dokler ni zaključena 100 % vsa projektna dokumentacija (Hardin 2009, str.Chapter1/str8). Ko je ta dokončana, jo prejme gradbeni izvajalec v obliki papirnatih risb ali PDF in CAD datotek. Če je v papirnati obliki, mora izvajalec najprej uporabiti računalniški program, ki prepoznava črte ali digitalizator, ki pomaga cenilcu slediti dokumentom in količinsko opredeliti objekte, kot so stene, tla in strope, število vrat in opreme, obenem pa primerjati med seboj povezane risbe, da razjasni ali je skozi dokumentacijo namen arhitekta dovolj nazorno opredeljen. Slabost tega postopka je, da je velik del ocene odvisen od strokovne usposobljenosti cenilca, da pravilno interpretira podatke z risb. Poleg tega je postopek dolgotrajen, cenilec pa pogosto potrebuje tudi povratne informacije od arhitekta, zato se pogosto dogaja, da se zaradi časovne stiske in težavnosti postopka, pogosto odpravlja samo večje pomanjkljivosti, manjše pa se prestavlja na kasnejši rok.

Integrirana izvedba projektov pa je nasprotno pripeljala do sočasne *analize stroškov po metodi ABC* (ang. *Activity Based Cost*, v nadaljevanju ABC). Če tradicionalna kalkulacija temelji na količinskih normativih po postavkah in vrstah virov (materialni viri in viri dela), vsak normativ materialnega vira pa vsebuje tudi pripadajočo količino povprečnega normativnega transporta, sklepamo, da je vrednost dveh enakih stolpnic dvakratnik vrednosti ene stolpnice. Nasprotno pa ABC metoda upošteva dejansko načrtovane aktivnosti, vire in stroške za njihovo izvedbo, zato pri gradnji dveh stolpnic upošteva dejstvo, da potrebujemo le en žerjav, kar že vpliva na nižjo ceno obeh stolpnic (Nemec Pečjak 2017, str.13).

Tako izvajanje poglobljene EVA analize kot analize stroškov po metodi ABC je zahtevno opravilo, saj potrebujemo redno posodobljene in točne podatke, zahtevne izračune in bazo znanja ter nenazadnje izkušenega projektnega managerja, da bi lahko dobili merodajne rezultate. Da bi v današnjem izvajanju vse bolj hitrih, zapletenih in obsežnih projektov, imeli pod nadzorom, kot mu pravi Nemec Pečjak, celoten projektni »Triglav«, to so čas, viri in stroški, je nujna uporaba integrirane podpore projektivi, zato se je oblikovalo **skupno podatkovno okolje CDE** (ang. *Common Data Enviroment,* v nadaljevanju CDE).

CDE je centralna točka, ki združuje vse projektne informacije na enem mestu. Vsi udeleženci projekta lahko vnašajo in do njih dostopajo, tako grafične podatke, kot so risbe, načrti in dokumenti, kot tudi negrafične podatke, kot so cene, tehnične lastnosti, garancijski pogoji, čeprav lahko le–ti delajo v različnih programskih okoljih. McPartland iz organizacije NBS, izpostavlja sledeče *prednosti uporabe CDE* okolja (McPartland 2016):

- podatki, ki so v skupni rabi so posledično usklajeni, zato zmanjšajo čas in stroške projekta,
- vsi člani projektne skupine lahko uporabljajo CDE za ustvarjanje dokumentov in pogledov, ki jih potrebujejo, z uporabo različnih kombinacij centralnega inventarja informacij, z zagotovilom, da uporabljajo najnovejše informacije (tako kot tudi drugi uporabniki CDE),
- prostorska koordinacija je neločljivo povezana z idejo o uporabi centraliziranega modela,
- proizvodni podatki morajo biti pravilni že prvič, ob predpostavki, da sodelujoči upoštevajo pravila postopkov za izmenjavo informacij,
- lastništvo informacije ohranja tisti, ki je informacijo ustvaril.

Dolenc deli oblike zagotavljanja CDE-ja od preprostih do namenskih CDE storitev v oblaku (Dolenc 2017, str36). Rock pa jih deli podrobneje, kjer so CDE-ji oblikovani kot skupni mrežni disk, ekstranet ali projektni strežnik, vedno bolj pa se uporabljajo CDE-ji, ki temeljijo na oblačnih storitvah in zagotavljajo digitalni prostor namenjen shranjevanje in skupni rabi informacij (Rock 2017).

Slabost CDE pa je, da zaradi centraliziranosti informacij v skupen vir, daje *gostitelju CDE-ja pomembno vlogo* pri gradbenim projektom. Kot ugotavlja Rock, deležniki gradbenega projekta najverjetneje ne bodo imeli lastnega digitalnega prostora za shranjevanje z zmogljivostmi, potrebnimi za BIM-pristop, zato se za digitalni prostor pogosto najame zunanji ponudnik. Pogodbe za najem pa na ponudnika storitev v oblaku ne prenašajo nikakršne odgovornost ali pa so te majhne, zato stranka, ki je odgovorna za ureditev gostovanja CDE-ja, morda ne bo mogla prenesti tveganj na zunanjega ponudnika storitev v oblaku (Rock 2017).

Naslednja slabost, ki izhaja iz centraliziranosti informacij v CDE-ju, je *vprašanje varnosti oziroma varovanja podatkov*, ki se nahajajo v CDE-ju. McPartland iz NBS pravi, da bi

zloraba, izguba, nenamerno razkritje ali kraja informacij lahko močno prizadela uporabnike, zgrajen objekt kot tudi informacije, ki so povezane z objektom ter da bi se morebitni negativni učinki lahko dodatno povečali, če bi se ti podatki nadalje zbirali, združevali ali medsebojno povezovali (McPortland 2015).

3 INFORMACIJSKO MODELIRANJE GRADENJ - BIM

Začetek BIM-pristopa sega v leto 1974, ko je Eastman s sodelavci nastavil koncept BIM-pristopa v raziskovalnem poročilu Osnutek opisnega sistema gradenj (ang. *An Outline of the Building Description System*). V njem opiše pomanjkljivosti risb in izpostavi, da se spremembe na že zgrajeni zgradbi naredijo vedno po ločenih risbah, kar vodi do tega, da se risbe zgradbe začnejo kopičiti in po določenem času ne obstaja več enoten arhiv risb, ki bi opisovale trenutno stanje, zato se zavedeno stanje zgradbe s časom vedno bolj kvari. Rešitev tega problema pa je računalniški model, ki iz enega vira informacij avtomatično generira potrebne risbe, kot tudi zapisuje stanje zgradbe v bazo podatkov, ki služi tudi za kvalitativne in kvantitativne analize (Eastman 1974, str.5). Če se je v strojništvu parametrično konstruiranje uveljavilo že konec 80-ih in začetku 90-ih letih, pa se BIM-pristop v gradbeno panogo uveljavlja relativno pozno. Po mnenju Bernsteina in Pittmana je eden izmed razlogov za tako pozno uvajanje v tem, da so bile, po podatkih iz leta 2000, naložbe v razvoj tehnologij v celotnem svetovnem gradbeništvu za skoraj šestkrat manjše od ostalih, podobno velikih panog z izjemo kmetijstva, kar je povzročilo razkorak v produktivnosti med gradbeništvom in ostalimi panogami, prikazan v diagramu na Sliki 4 (Bernstein, Pittman 2004).

Slika 4: Razkorak pruduktivnosti v svetovnem merilu

Vir: Bernstein, Pittman 2004, str.3 .

Tako Mazen kot Phiri trdita, da je kratico BIM prvič uporabil Bernstein, podpredsednik Autodesk-a, a temu oporeka spletna stran the BIM Hub, ki pravi, da je bil izraz "Building Information Model" prvič v angleščini dokumentiran v prispevku van Nederveena in Tolmana leta 1992, iz TU Delft na Nizozemskem (Mazen 2015; Phiri 2016, str.11; the

BIM Hub 2014). Aish, zdaj član Autodesk Research-a, je že leta 1986 prvi uporabil izraz "Building Modeling" v pomenu, ki ga danes uporabljamo za BIM-pristop. Tako Mazen kot the BIM Hub, pa se strinjajo, da je za popularizacijo kratice BIM najbolj zaslužen Laiserin, sam Laiserin pa pravi, da se sam vidi, kot boter BIM-a, pravi oče BIM-a pa je Eastman (Eastman et al, 2008, str.xiii). Ne glede na dileme, pa je vloga Bernsteina pri uveljavljanju BIM-pristopa nesporna bistvena, saj je zaslužen za *utemeljitev interoperabilnosti*, ki jo bom predstavil v tem poglavju.

3.1 Kaj je BIM?

Trenutno je v slovenščini razširjen izraz »informacijsko modeliranje zgradb«, ki pa po mnenju Nemca ni najbolj ustrezen, saj ima beseda »*building*« lahko dva različna pomena v angleščini, in sicer gradnja kot proces ali pa zgradbo kot objekt, zato bi bil ustreznejši prevod **»informacijsko modeliranje gradenj«**, saj z gradnjo vključujemo tako visoke kot tudi nizke, prav tako pa posega BIM-pristop tudi na druga področja, kot je na primer strojegradnja (ladjedelništvo, itd.) (Nemec Pečjak 2017, str.7). Podobno kot Nemec Pečjak ugotavlja tudi združenje buildingSMART, da beseda »*building*« ne zajema samo gradbeništva, temveč celotno grajeno okolje (buildingSMART b.l.).

Na enako dilemo naleti tudi Phiri, kjer v slovarju opredeljuje kratico BIM na 3 različne pomene (Phiri 2016, str.xiii):

- *Building information model* kot *produkt***,** ki je digitalna predstavitev fizičnih in funkcionalnih karakteristik objekta;
- *Building information modelling* kot *proces* in je zbirka definiranih uporab BIM-modela, delovnih tokov in modelirnih metod, za doseganje specifičnih, ponovljivih in zanesljivih informacij, ki jih lahko dobimo iz BIM-modela. Metode modeliranja vplivajo na kakovost informacij, ki jih generiramo iz BIM-modela. Kdaj in kako je model uporabljen ter deljen, vpliva na učinkovito uporabo BIM-modela za doseganje želenih ciljev projekta ter podporo pri sprejemanju odločitev;
- *Building information management* kot *upravljanje podatkov*, kar pomeni upravljanje s podatki na tak način, da le-ti podpirajo podatkovne standarde in zahteve, ki so potrebni za uporabo v BIM-pristopu. Neokrnjena kontinuiteta podatkov tako omogoča zanesljivo izmenjavo informacij v kontekstu, da tako prejemnik kot pošiljatelj razumeta izmenjano informacijo na enovit način.

Britanska organizacija NBS definira BIM-pristop na sledeč način: »BIM ali informacijsko modeliranje zgradb je proces za izdelavo in management informacij o gradbenem projektu, skozi celoten življenjski cikel projekta. Eden od ključnih produktov tega procesa je informacijski model gradnje, to je digitalni opis vseh vidikov zgrajenega objekta. Ta model temelji na skupaj zbranih skupnih podatkih, posodobljenih v ključnih fazah projekta. Ustvarjanje digitalnega informacijskega modela gradnje omogoča tistim, ki upravljajo z

zgradbo, da optimizirajo svoja dejanja, kar ima za posledico večjo vrednost sredstva skozi njeno celotno življenje.« (NBS 2016).

Ameriški Nacionalni odbor za standardizacijo BIM-a NBIS-US (ang. *National BIM Standard-United States*), pa opredeljuje BIM-pristop kot: »Digitalna predstavitev fizičnih in funkcionalnih značilnosti objekta. BIM je deljen skupni vir informacij o objektu, ki predstavlja zanesljivo podlago za sprejemanje odločitev v življenjskem ciklu; ki je definiran od zgodnje zasnove do rušenja. BIM je skupna digitalna predstavitev, ki temelji na odprtih standardih za interoperabilnost.« (NBIS-US 2014).

Obe definiciji, kaj naj bi BIM bil, sta si torej zelo podobni, saj sta obe organizaciji članici mednarodnega združenja **buildingSMART,** ki skrbi za mednarodno uveljavitev odprtih standardov za BIM, ki so podlaga za interoperabilnost in posledično ustvarjanje CDE-ja. Phiri poenotenje definicij BIM-pristopa smatra kot zelo pomembno dejstvo, saj se različne interpretacije obravnavajo kot ovire za splošno sprejetje in široko uporabo BIM-pristopa (Phiri 2016, str.10).

A ker obe definicije, po mojem mnenju, BIM-postopka ne opisujeta dovolj nazorno, bom povzel opis BIM-pristopa po Phiriju. Ta pravi, da se je zanašanje na podatke iz 2D CAD risb, ki se pretežno uporabljajo v tradicionalnih pristopih k izvajanju gradenj, razširilo v BIM-pristopu preko meja 2D in 3D geometrije in jih najprej nadgradil s 4D, časom in 5D, stroški. Kot smo spoznali v poglavju 1.3., se morajo pri tradicionalnih 2D načrtih potrebne količine izračunati na težaven in postopen način, medtem ko se v BIM-pristopu kosovnice za potrebne količine in dobavni ter vgradni roki generirajo avtomatično, kar omogoča mnogo lažjo izvedbo stroškovnega in terminskega planiranja. BIM-pristop prav tako omogoča analizo prostorskih razmerij, svetlobne analize, geografsko umestitev gradnje na terenu, kot tudi količine in lastnosti vgrajenih gradbenih materialov ter komponent. Zaradi prikaza konstrukcije kot kombinacijo objektov – lahko so povsem brezoblični in nedefinirani, generični ali pa so specifični za posamezen produkt; kot trdna telesa ali samo orientirane praznine, kot so npr. sobe – kateri vsak zase nosi svojo lastno geometrijo, relacije in atribute, je možno z BIM-pristopom iz BIM-modela pridobiti različne poglede za izdelavo risb, detajlov in specifikacij. Ker so bazirani na lastni definiciji vsakega posameznega objekta, so vsi generirani pogledi avtomatično konsistentni. BIM-programi omogočajo definirati BIM-objekte kot parametrične, torej z definiranimi razmerji z ostalimi BIM-objekti, tako da se pri spremembi enega BIM-objekta, skladno spremenijo tudi vsi ostali, od tega BIM-objekta odvisni BIM-objekti. Vsak BIM-objekt lahko nosi atribute za njihovo posamično izbiro in avtomatsko naročilo, kar omogoča oceno stroškov in naročilo ter sledenje naročilom materiala in komponent. Za konstruktorje in načrtovalce gradbenega projekta (arhitekte, statike, projektante vodovodnih, električnih, strojnih in drugih inštalacij, stroškovne analitike ter vzdrževalce objektov) zagotavlja BIM-model virtualni informacijski model, ki se preda izvajalcem gradnje objekta in ob zaključitvi gradnje k lastnikom ali upravljavcem objekta za učinkovito upravljanje. BIM-pristop omogoča vsakemu strokovnjaku, da lahko doda razširjene podatke, ki so specifični za njegovo področje, na en sam, skupen model, ter se tako zmanjša izguba informacij, ki se

običajno dogaja ob predaji lastništva nad projektom novim izvajalcem, kar je običajno lastnost tradicionalnih pristopov (Phiri 2016, str.12). BIM-pristop je torej proces generiranja in managementa digitalnih in funkcionalnih karakteristik objekta, da bi dobili BIM-modele, ki nato postanejo skupen vir znanja za podporo pri sprejemanju odločitev skozi celoten življenjski cikel, od zasnove do konstrukcije, izgradnje in končne uporabe vse do razgradnje objekta in je prikazan na Sliki 5 (Phiri 2016, str.10).

Slika 5: BIM-pristop v življenjskih fazah gradnje

Vir: Arhitekturni biro CASA Solo Arquitecto 2017.

Vse to pa ne bi bilo mogoče, če se v začetku ne bi postavil enoten temelj, na katerem je zgrajen celoten BIM-pristop in mu pravimo *interoperabilnost*.

3.1.1 Interoperabilnost

Bibliotekarski terminološki slovar definira interoperabilnost kot sposobnost sistema, da sodeluje z okoljem drugega sistema brez uporabnikovega poseganja, npr. omogočanje povezljivosti informacijskih virov na internetu (Kanič et al. 2009**).** Interoperabilnost torej pomeni zmožnost izmenjave datotek med različnimi programi in aplikacijami, ki so namenjeni različnim deležnikom.

Gallaher in sodelavci so leta 2004 za Ameriški inštitut za standarde in tehnologijo (ang. *National Institute of Standards and Technology, NIST*) v svojem poročilu konservativno ocenili, da so samo ameriška gradbena podjetja, ki izvajajo velike gradbene projekte (v

raziskavi so bila obravnavane samo komercialne, institucionalne in industrijske gradnje) v letu 2002 zaradi *pomanjkljive interoperabilnosti* ustvarila 15,8 milijarde dolarjev izgub. Vir izgub so predvsem pomanjkljiva komunikacija in vzdrževanje podatkov že realiziranih gradenj, napak v komunikaciji med deležniki, nezadostna standardizacija in pomanjkljiv nadzor v vsaki fazi življenjskega cikla gradnje, kar so pomanjkljivosti, ki izhajajo predvsem iz tradicionalnih pristopov. Ugotovili so, da 2/3 delež teh izgub nastane v fazi uporabe in vzdrževanja gradnje, kar posledično pomeni, da se prenašajo od začetka verige na končnega uporabnika / lastnika. Poročilo pa ni zajelo tudi drugih skritih stroškov, ki jih je težko kvantificirati, kot so npr. izguba prihodnjih priložnosti (Gallaher et al. NIST 2004, str.iv, str 7-1). Poročilo ugotavlja, da arhitekti in inženirji nosijo najmanjši delež stroškov, ki nastanejo zaradi pomanjkanja interoperabilnosti, zato posledično nimajo zadostne spodbude, da bi jo tudi udejanjili, saj obstaja velika verjetnost, da delajo za naročnika samo enkrat. Kot drugi dejavnik pa navajajo pomanjkanje interne organizacije informacij, ki bi temeljila na skupnem podatkovnem okolju CDE in bi omogočalo hitro ter učinkovito poslovno odločanje.

Za doseg interoperabilnosti je potrebno imeti odprte standarde, ki omogočajo oblikovanje odprtega standardiziranega podatkovnega formata. Kot navaja spletna stran združenja buildingSMART, je prvi koraki v smeri večje interoperabilnosti storilo podjetje Autodesk, ki je leta 1995 dalo pobudo in se skupaj s še drugimi 12 podjetji, ki so vpletena v razvoj računalniških programov za oblikovanje, konstrukcijo in gradnjo, sestalo, da bi skupaj potrdili prednosti interoperabilnosti. Po letu dni delovanja so prišli do treh ključnih skupnih zaključkov (buildingSMART b.l.):

- interoperabilnost je možna in ima velik komercialen potencial,
- standardi morajo biti odprti in mednarodni in ne zasebni ali lastniški, ter
- združenje mora biti odprto za pristop vsem, ki želijo sodelovati.

Iz zasebnega zavezništva se je leta 1996 oblikovalo združenje IAI (ang. *International Alliance for Interoperability*), ki se je nato leta 2008 preimenovalo v buildingSMART, z namenom, da bi bolje odražalo bistvo in cilje združenja, ki je za cilj postavilo dogovor o skupnem temelju odprtega standarda. BuildingSMART je od leta 2011 dalje član organizacije ISO (ang. *International Organization for Standardization, ISO*), kjer tudi vodi tehnični odbor, odgovoren za IFC standard ter od leta 2013 organizacije OGC (ang. *Open Geospatial Consortium, OGC*), ki je odgovorna za geografske in geoprostorske standarde.

OpenBIM je iniciativa združenja buildingSMART, da se podprejo *trije tehnološke stebri*, ki so potrebni za doseganje interoperabilnosti:

- *IFC* (ang. *Industry Fundation Classes*) je odprt, nevtralen podatkovni format, ki ga je zasnoval buildingSMART za univerzalni pristop k sodelovalnemu, skupinskemu snovanju objektov, delovnim procesom, gradnji ter upravljanju. IFC model vključuje tako geometrične (2D ali 3D) kot tudi negeometrične informacije o modelu (cena,

lastnosti materiala). Ker sloni na ISO standardizirani predlogi, omogoča izmenjavo datotek med različnimi BIM-orodji in aplikacijami;

- *IFD* (ang. *International Framework for Dictionaries Library, IFD*) je katalog konceptov in terminov, ki zajema različne jezike in vključuje tudi zaščitene programske dialekte (Benley speak, Revit speak). S tem se izognem problemu babilonskega stolpa in lahko tvorimo knjižnice BIM-objektov, ki lahko vsebujejo tudi fotografije, video posnetke, podatke o meritvah, priključne sheme, statične analize, recepture, tehnološke liste itd. (Nemec Pečjak 2017, str.48);
- *IDM / MVD* (ang. *information delivery manuals / model view definition*) - kot pravi Karlshøj, je ISO standard razvit zato, da bi imeli pri izdelavi BIM-modela enovito metodologijo za zajem in opredelitev procesov in pretoka informacij, skozi celoten življenjski cikel gradnje (Karlshøj 2011). Priročnik tako opredeljuje vse, kar mora vsebovati končni BIM-model, da ob predaji k naročniku projekta tudi pravilno deluje v naročnikovi programski opremi.

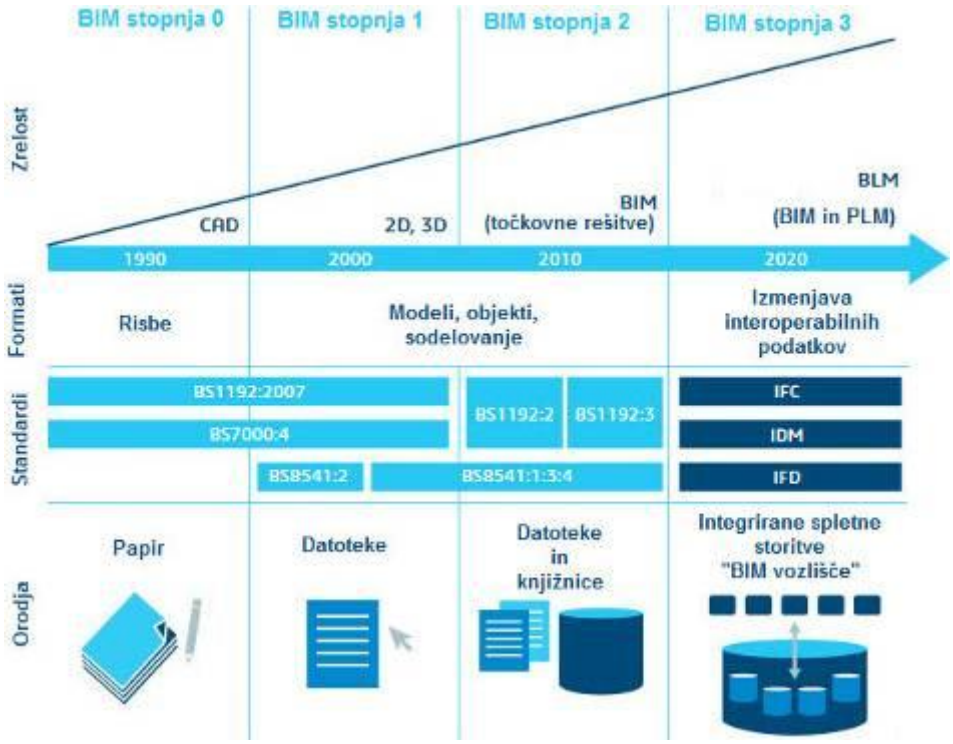
Poleg nevtralnega, odprtega podatkovnega formata **IFC** (ang. *Industriy Fundation Classes*) je za doseganje interoperabilnosti izjemno pomemben **COBie** (ang. *Construction Operations Building Information Exchange, COBie*). COBie je mednarodno priznan standard, ki je namenjen generiranju digitalne, negeometrične podatkovne knjižnice za potrebe vzdrževanja in upravljanja objektov. Standard je oblikoval East leta 2007, po naročilu ameriške vojske (ang. *United States Army Corps of Engineers*). Kot pravi East, je bil srž problema pomanjkanje volje s strani lastnikov, da bi identificirali svoje potrebe in zahteve na generičen način, ki bi omogočil nadaljnjo standardizacijo (East 2007, str 5). Da bi omogočil interoperabilnost med programi ter neproblematično predajo BIM-podatkovne baze po izgradnji objekta upravljavcem in lastnikom, je COBie oblikovan kot derivat IFC-formata in določa strukturo ter format podatkovnega zapisa. Podatki so urejeni v Excel tabelah, v katerih se nahajajo informacije o gradnji in vgrajeni opremi, kot so na primer podatki o dobavitelju, serijska številka opreme, datum vgradnje, zahtevani intervali vzdrževanja, podatki o prostorih in podobno. Klasifikacija je odprtega tipa in prepuščena potrebam uporabnikov, kar omogoča da se različne države odločajo za različne standardizirane klasifikacije. Tako ima na primer ZDA klasifikacijo Omniclass, medtem ko se je v VB oblikoval Uniclass.

Ker je COBie zapis preprost (XML tabele), zanj ni potrebno uporabljati specifičnih BIM-orodij in poznavanje IFC podatkovnega zapisa, zato je dostopen za uporabo in manipulacijo širokemu spektru uporabnikov. Za COBie je predvsem pomembno, da se podatki v COBie-bazi kontinuirano posodabljajo skozi celotno življenjsko dobo gradnje, torej od osnutka do razgradnje gradnje. S tem se pridobi vpogled v celotne življenjski cikel gradnje in možnost naknadne analize podatkov, ki so lahko osnova za izboljšanje delovanja obstoječih ali prihodnjih gradenj.

3.1.2 BIM-stopnje

BIM-pristop je skozi leta razvoja, skupaj z razvojem IKT-ja in projektnega managementa omogočil izvajanje vedno bolj kompleksnih gradbenih projektov, ki glede na kompleksnost, zahtevajo različne stopnje tehničnega in medsebojnega sodelovanja. Za jedrnat, nedvoumen opis in razumevanje procesov, orodij in tehnik, ki se uporabljajo na posameznem projektu, se uporabljajo *zrelostne stopnje BIM-pristopa*, ki kategorizirajo tipe tehničnega in sodelovalnega dela, kot je prikazano na Sliki 6.

Slika 6: Zrelostne stopnje BIM-pristopa



Vir: Dassault Systems 2016, str.2.

Stopnja 0 je neusklajena, računalniško podprta konstrukcija, običajno z 2D CAD programi. Najverjetnejši podatkovni formati, ki se med deležniki projekta običajno izmenjujejo,so papirnate ali digitalne risbe.

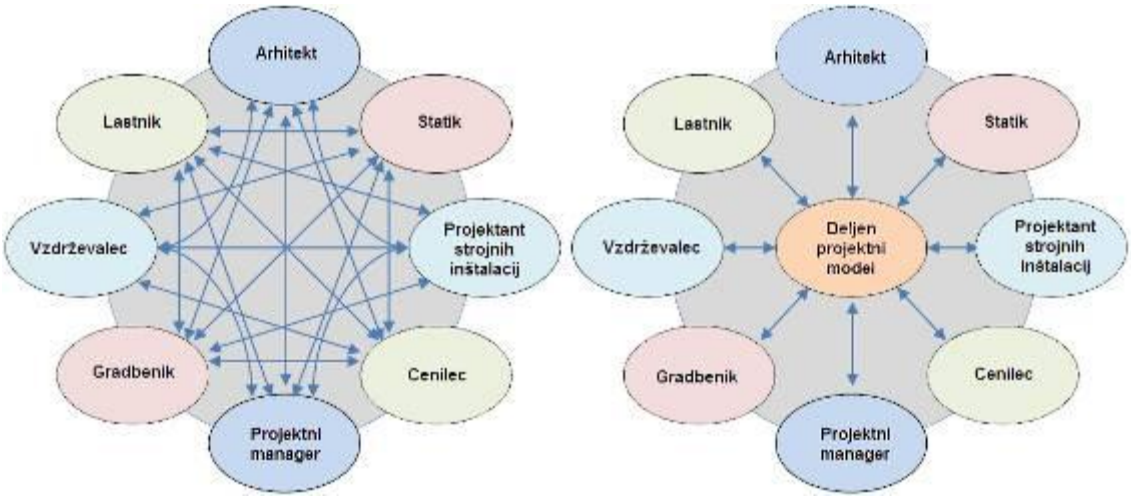
Stopnja 1 je usklajeno, računalniško podprto konstruiranje, ki poteka z 2D ali 3D CAD programi s sodelovalnim orodjem, ki omogoča uporabo CDE-ja. Možna je tudi uporaba standardnih podatkovnih struktur in formatov. Generirani 2D in 3D-modeli se na tej stopnji še vedno ne delijo med posameznimi deležniki projekta. Prav tako se vodijo komercialni podatki s samostojnimi programi za planiranje in kontrolo terminov in stroškov, brez možnosti integracije podatkov v CAD-modele.

Stopnja 2 je začetek integriranega izvajanja projektov. Imamo usklajeno 3D okolje, kjer so 3D-modeli obogateni z dodatnimi, negeometrijskimi podatki, kot so 4D terminski in 5D

stroškovni podatki, kot tudi sistem poročanja, ki omogoča terminsko in stroškovno planiranje ter kontrolo pri izvajanju projekta. Deležniki projekta lahko uporabljajo različne 3D CAD-programe in generirajo lastne 3D-modele, ki pa so zaradi uporabe enakega podatkovnega formata (običajno IFC in/ali COBie), zmožni kasnejše integracije v eno celoto, ter tako omogočijo preliminarna preverjanja, ki so potrebna za kasnejšo nemoteno izvedbo projekta. Komercialni podatki se upravljajo s programi za načrtovanje virov podjetja (ang. *Enterprise Resource Planning, ERP*). Izdelava in integracija 3D-modela je možna tudi z lastniškimi (*proprietary*) podatkovnimi formati neodprtega tipa (npr. dxf in rvt format) in CAD programi, kar se imenuje »lastniški BIM« (ang. *proprietary BIM, pBIM*).

Kot prikazuje Slika 7, ima *stopnja 3* za vse deležnike projekta popolnoma odprt dostop, ki tako lahko sočasno izvajajo konstrukcijske procese in jih nato preko spletnih storitev, ki so v skladu z IFC in IFD standardi, integrirajo v usklajen, sodelovalni BIM-model na centralnem strežniku.

Slika 7: Razlika poteka informacij med tradicionalno izvedbo in BIM-pristopom



Vir: Ryan 2013.

Na tej stopnji se srečamo z izrazom »integriran BIM«. Organizacija Dassault Systems je 3. stopnjo opisala kot združitev BIM-a in PLM-a (ang. *product life management*), kjer vnos BIM-podatkov v PLM sistem ustvarja management življenjskega cikla gradnje (ang. *Building Lifecycle Management, BLM*) (Dassault 2016, str.3). Phiri meni, da bo stopnja 3, skozi konvergenco ciljev konstrukcije, energetike, trajnostnega razvoja in rasti tržišča pripeljala na novo stopnjo, kjer bo osrednji cilj učinkovito upravljanje in vzdrževanje grajenega okolja ter spremljanje in merjenje, kako učinkovito grajeno okolje tudi dejansko deluje (Phiri 2016, str.7). Nemec Pečjak meni, da naj bi po napovedih stopnjo 3 dosegli v letu 2020 (Nemec Pečjak 2017, str.19).

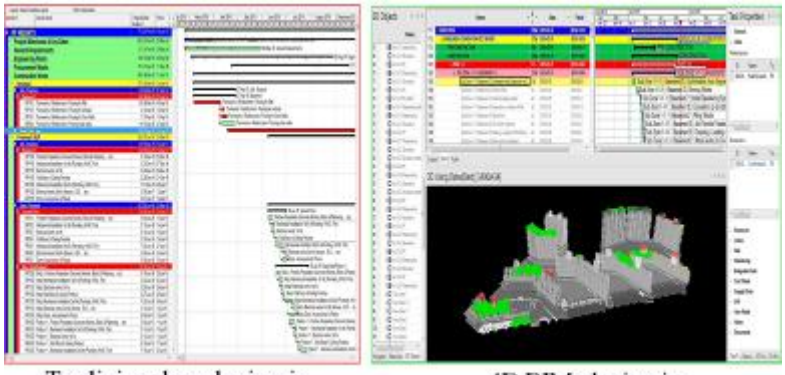
3.1.3 BIM-razsežnosti

Možnost plemenitenja BIM-modelov z drugimi, negeometrijskimi podatki odpirajo nove dimenzije in s tem tudi možnosti, kako pristopiti k izvajanju in managementu gradbenih projektov, kot tudi rezultatov teh projektov.

3D BIM je začetna stopnja in se loči od 3D CAD-modela z možnostjo vsebovanja negrafičnih podatkov. Kot razlaga Fram, so 3D BIM-programi namenjeni izključno modeliranju gradenj, običajno z uporabo 3D BIM-objektov iz knjižnice, medtem, ko so orodja za 3D modeliranje v BIM-programih manj robustna (Fram 2017). Preko CDE-ja lahko BIM-model delimo z drugimi udeleženci projekta, ki z napredovanjem projekta ravno tako bogatijo 3D BIM-model, ta pa se ob dokončanju projekta preda lastniku/naročniku.

4D BIM dobimo, ko 3D-modelu dodamo komponento **časa,** torej čas trajanja posamezne aktivnosti. Z določitvijo zaporedja aktivnosti pri gradnji, dobimo možnost virtualne simulacije poteka gradnje (ali razgradnje) objekta in kontrolo izvajanja aktivnosti, kjer primerjamo rezultate, dobljene s posnetki kamer, ki snemajo stanje na gradbišču z rezultati pridobljenimi na podlagi simulacij. 4D BIM-model se uporablja za kreiranje gantogramov in CPM diagramov, orodij, ki jih poznamo iz projektnega managementa in poglavja 1.1. 4D BIM programi lahko združijo skupaj 3D CAD model gradnje, ki je v formatu IFC in terminski plan iz MS Project v formatu XML v enoten 4D BIM-model. Primerjava med MS Project in 4D BIM-modelom je podana na Sliki 8.

Slika 8: Gantogram iz MS Project in 4D BIM-model



Vir: Elgohari 2016.

Dengenis je mnenja, da je 4D BIM naslednja generacija, vključno s planiranjem projektov in analizo podatkov, ter da od izuma gantograma in CPM-a ni bilo večjih inovacij na področju gradbeništva, vse do 4D BIM-a, ki dobesedno doda vizualni vpogled v virtualni potek projekta (Dengenis 2014). Po Phiriju velja izpostaviti tudi vidik varnosti, saj lahko organizacije, ki uporabljajo 4D BIM-modele, zaradi vizualizacije poteka del tudi bolje

razumejo, načrtujejo in upoštevajo varnostne vidike pri gradnji, bolje ocenijo razmere za delavce na gradbišču, prepoznavajo potencialne nevarnosti ter načrtujejo, analizirajo in potrjujejo varnostne ukrepe (Phiri 2016, str.44). Nemec Pečjak pravi, da se lahko 4D BIM uporablja tudi za finančni nadzor izgradnje, tako da primerjamo izstavljene vmesne obračune s planskimi situacijami iz 4D BIM-modela, a je temu bolj namenjena naslednja dimenzija BIM-pristopa (Nemec Pečjak 2017, str.23).

5D BIM označuje vnos *cen in stroškov gradnje* v 4D BIM-model, kar nam omogoči planiranje in kontrolo stroškov projekta. Kot smo že omenili v poglavju 2.4, je 5D BIM skladen z razvojem *analize stroškov po metodi ABC*, s katero lahko že v fazi načrtovanja projekta dobimo, s kakovostno pripravljenim 5D BIM-modelom, ocene končnih stroškov in terminsko planiranje poteka financiranja. Nemec Pečjak celo trdi, da: »je tak predračun, obračun in kontrolo možno uspešno izvajati le z ustreznim namenskim programom, ki temelji na 5D BIM.« (Nemec Pečjak 2017, str.12). Z uporabo namenskih programskih aplikacij, ki so povezane z BIM-orodji, se izboljša produktivnost stroškovnih cenilcev, s centralizacijo stroškovnih podatkov pa se zmanjšajo tudi napake.

Do 5D BIM-a je literatura poenotena pri opredeliti dimenzij, kasneje pa se delita na dve skupini, in sicer v prvi skupini, ki definira še 7D-BIM, pri drugi pa se zaključi s 6D BIM-om. V prvi skupini se obravnava *6D BIM* kot *trajnostna gradnja,* srečamo pa se tudi z izrazom »zeleni BIM« (ang. *green BIM*). Z vnosom tehničnih karakteristik vgrajenih materialov in komponent dobimo BIM-model, s katerim lahko v programih za energetsko analizo modelov (ang. *energy analysis models, EAM*) analiziramo in predvidimo kakšna bo *energetska poraba objekta*, kot tudi komunalne stroške, npr. porabo vode, skozi njeno celotno življenjsko obdobje. Tako lahko zmanjšamo stroške zaradi manjše porabe energije in virov, izboljšamo delovanje objekta ter naredimo gradnjo trajnejšo in okolju prijaznejšo. Nezanemarljiv je podatek, ki ga omenjata tako Cerovšek kot Singh, da stroški obratovanja objekta predstavljajo po 20-ih letih kar 5-kratnik zneska investicije v izgradnjo (Cerovšek 2013, str.7; Singh 2014). Podatki zbrani skozi daljša obdobja bodo služili za prihodnje analize in ocene, do katere mere so se prednosti uporabe BIM-pristopa na koncu tudi dejansko realizirale.

Sledi še *7D BIM,* ki jih spletne strani BIMpanzee, theBIMHub in arhitekturni biro Košorok Gartner razvrščajo v lastno kategorijo in obravnava *informacije v življenjski dobi projekta* (ang. *project lifecycle information*), medtem ko jo tako organizacija NBS kot Phiri enačita z 6D BIM-om. Dodatno se 6D/7D BIM v VB opušča in ju nadomeščata izraza *zahtevane informacije o sredstvih (zgrajenih objektih)* (ang. *Asset Information Requirement - AIR*) in *model informacij o sredstvih (zgrajenih objektih)* (ang. *Asset Information Model - AIM*).

V BIM-modelu so zajete vse informacije, ki so v prvi vrsti namenjene upravljavcem in vzdrževalcem gradnje, potrebne za učinkovito in preventivno vzdrževanje gradnje, kot so referenčne oznake modela vgrajene opreme, kontaktni podatki proizvajalca ali servisa, vzdrževalni intervali in garancijski pogoji. BIM-model omogoča tudi vpogled v prepletenost in vzajemne odnose delovanja podsistemov gradnje, zato je lažje in hitreje

locirati in sanirati napake v delovanju ali oceniti možne nadgradnje. Ker se informacije zbirajo že v fazi snovanja, imajo vzdrževalci možnost zgodnjega aktivnega sodelovanja ter predčasnega spoznavanja in šolanja za kasnejše upravljanje z gradnjo preko BIM-programov. Podatki se lahko izvozijo v COBie format, za uporabo v orodjih vzdrževalcev gradnje, ki se nato z uporabo redno posodabljajo in nato vnašajo nazaj v centralni BIM-model. Tako imamo redno posodobljeno bazo znanja in centralni vir informacij, ki med kot tudi na koncu življenjske dobe gradnje, omogoča vpogled in analizo delovanja celotne gradnje kot tudi njenih posameznih delov ter komponent, kar omogoča optimalno odločanje in iskanje rešitev tako za obstoječo gradnjo kot prihodnje gradnje.

3.1.4 Stopnje obdelave, podrobnosti in informacije

Kot je Eastman že leta 1974 pravilno ugotovil, je potrebno predhodno oceniti število posameznih delov, da bi v računalniškem programu, zgradbo na konstrukcijskem nivoju opisali kot njihov skupni sestav (Eastman 1974, str.7). Število komponent, ki vsebujejo grafične in ne-grafične informacije bistveno vplivajo na velikost končnega BIM-modela, kar je potrebno upoštevati pri izbiri IKT-opreme, ki se bo uporabljala tako med izvajanjem gradbenega projekta, kot tudi pri kasnejšem vzdrževanju. V primeru nenačrtovanja in usklajevanja, lahko pride do težav z deležniki projekta, ki nimajo primerne IKT-opreme in zaradi prezahtevnosti BIM-modelov ne morejo enakovredni participirati pri BIM-pristopu, ki pa v osnovi temelji na medsebojnem sodelovanju.

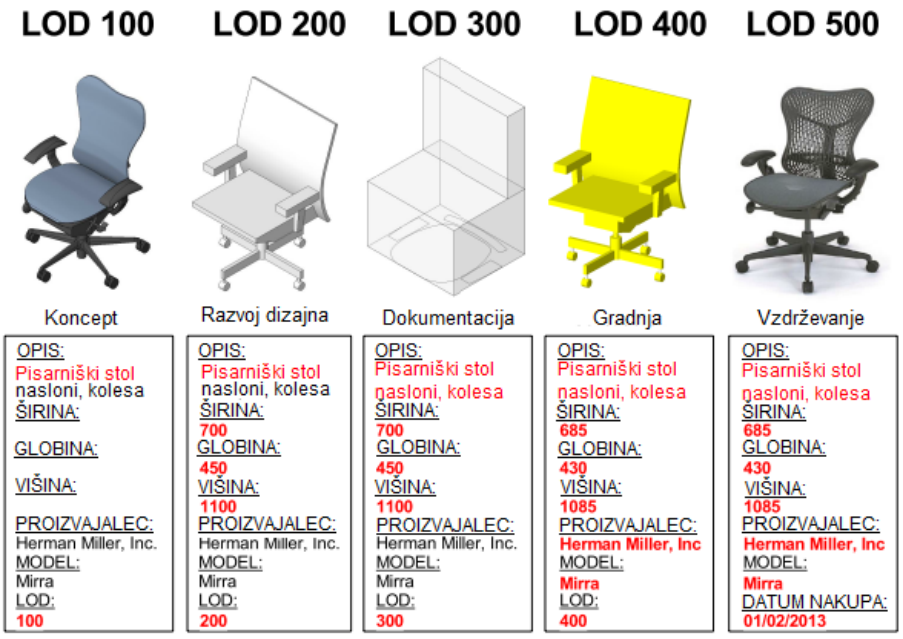
V literaturi se srečamo z dve terminoma, ki imata enake kratice a različen pomen, in sicer **stopnja obdelave LOD** (ang. *level of development,* v nadaljevanju LOD), ki zajema razvitost tako geometrijske kot negeometrijske vsebine, **stopnja podrobnosti LoD** (ang. *level of detail,* v nadaljevanju LoD) ki je namenjena samo opisu geometrijske vsebine ter **stopnjo informacij LOI** (ang. *level of information,* v nadaljevanju LOI), ki pa opisuje zgolj negeometrijsko vsebino modelov.

Kot pravi Leonova izhaja zmeda iz dejstva, da je kratico LOD prvotno uporabljalo podjetje Vicosoftware, ki se ukvarja s programsko opremo za izračun stroškov gradnje in se je glasila »stopnja podrobnosti«. Družba je bila ena od prvih, ki je razvila tehnike za določanje cen neposredno iz BIM-modelov in je uporabljala LOD, da bi lahko spremljala, kako dokončne so bile ocene stroškov. Ko je AIA prevzel ta koncept, so ohranili kratico LOD, a so spremenili pomen v »stopnjo obdelave«, saj bi se beseda podrobnost lahko interpretirala v smislu geometrijske podrobnosti, stopnja obdelave pa naglašuje stopnjo zanesljivosti. Zaradi zmede, ki je nastala med LOD in LoD, so nastale tudi druge specifikacije, ki opisujejo LOD in LoD (Leonova 2014).

Stopnja obdelave LOD je specifikacija, ki omogoča jasno opredeliti in sporočati vsebino in zanesljivost BIM-modelov ter BIM-objektov deležnikom projekta, v različnih fazah procesa načrtovanja in gradnje. Stopnja obdelave LOD nam pove, do katere stopnje sta geometrija modela in v model vnešena informacija premišljena, ali drugače, do katere stopnje se lahko člani projektne skupine zanesejo na informacijo pri uporabi BIM-modela.

Slika 9 prikazuje, da visoka grafična podrobnost še ne pomeni tudi visoko stopnjo zanesljivosti podane grafične informacije.

Slika 9: Stopnja obdelave LOD - samo podatki z rdečo barvo so uporabni



Vir: McPhee 2013.

Definicijo je razvil Ameriški inštitut arhitektov AIA (ang. *American Institute of Architects*, v nadaljevanju AIA) in se je v njihovi publikaciji prvič uporabila leta 2008, leta 2011 pa je pobuda **BIM Foruma** zaradi bolj konsistentne uporabe in širše standardizacije, postala licencirana s strani AIA za oblikovanje specifikacij LOD-a. Leta 2013 je BIM Forum izdal prve specifikacije, ki so enake kot AIA, z dvema razlikama, in sicer pri LOD 350 in LOD 500.

Tako zasledimo po AIA in BIM Forumu sledeče *LOD stopnje* (BIM Forum 2017, str.12):

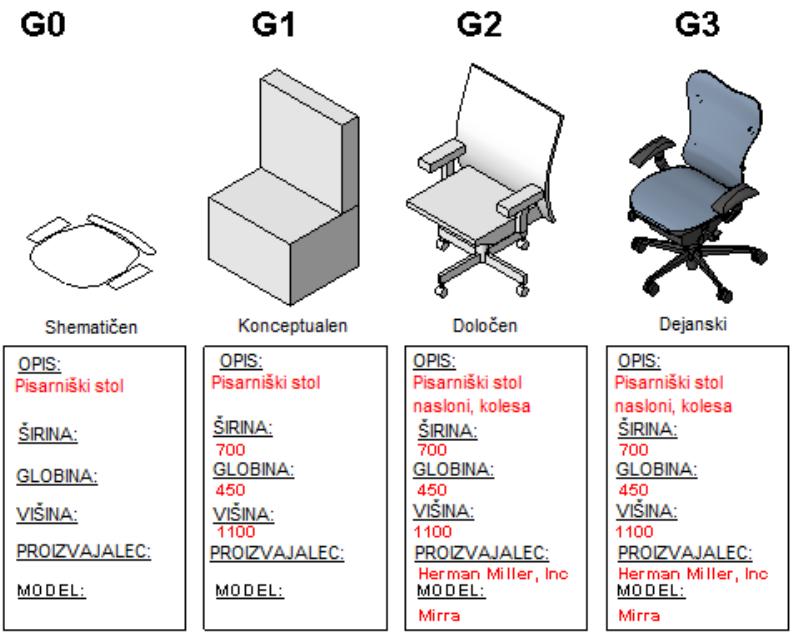
- *LOD 100* – je primerna za začetni fazi priprav in snovanja projekta. BIM-objekti nimajo geometrične predstavitve, temveč jih lahko predstavlja zgolj simboli, ki zgolj ponazarja obstoj objekta, ne pa tudi njegove oblike, velikosti ali točne lokacije. Vse informacije, ki jih dobimo iz tega modela se smatrajo kot približek za potrebe koncepta/osnutka;
- *LOD 200* – je namenjen fazi konceptualnega načrtovanja. Imamo generične BIM-objekte, s približnimi količinami, oblikami, lokacijami in orientacijami. Oblika BIM-objekta lahko ponazarja objekt ali pa volumen, ki ga objekt zaseda, prav tako imajo lahko dodano negrafično informacijo, ki pa se smatra samo kot približek;
- *LOD 300* – je namenjen fazi podrobnega načrtovanja. BIM-objekt ima grafično predstavitev, ki je dovolj reprezentativna, da lahko direktno iz BIM-objekta dobimo

količino, velikost, obliko, lokacijo in orientacijo, ne da bi se zanašali na negrafično informacijo, ki je lahko BIM-objektu dodana kot opis ali predpisane dimenzije;

- *LOD 350* – je namenjena fazi medstrokovnega sodelovanja in je enaka kot LOD 300, samo da imajo BIM-objekti dodatno zmodelirane dele, ki so potrebni za koordinacijo z drugimi BIM-objekti, s katerimi imajo interakcijo, na primer, podpore ali povezave. So dovolj razviti, da se omogoči podrobno usklajevanje med strokami, npr. odkrivanje kolizij, razpored, itd. Zahteve na tej stopnji so višje od LOD 300, vendar ne dovolj visoke za LOD 400. Specifikacija AIA definicije te stopnje ne vključuje in je dodana s strani BIM Foruma;
- *LOD 400* – je primerna za fazo izdelave tehnične dokumentacije, saj so BIM-objekti te stopnje dovolj podrobno in natančno zmodelirani, da so primerni za izdelavo ali gradnjo;
- *LOD 500* – je namenjen končnim fazam, to je gradnje in predaje projekta naročniku. BIM-objekt je preverjeno enak kot izdelan objekt v resničnosti in je primeren za končni BIM-model, ki se ga na koncu projekta preda upravljavcem in vzdrževalcem zgradbe. Medtem ko je LOD 500 vključen v definicijah AIA za LOD, se BIM Forumu ni zdelo, da je potrebno še naprej opredeljevati in ponazarjati LOD 500 v specifikacijah, saj se ta nanaša na preverjanje na terenu

Stopnja podrobnosti LoD (ang. *Level of Detail, LoD*) označuje stopnjo podrobnosti geometrije BIM-objekta oziroma njegovo vizualno reprezentativnost in se dviga v skladu z napredovanjem projekta. Tudi te še niso poenotene, zato so na Sliki 10 prikazane delitve po protokolu britanskega združenja AEC UK BIM (ang. *architecture, engineering and construction - AEC*).

Slika 10: Stopnja podrobnosti LoD - samo podatki z rdečo barvo so uporabni



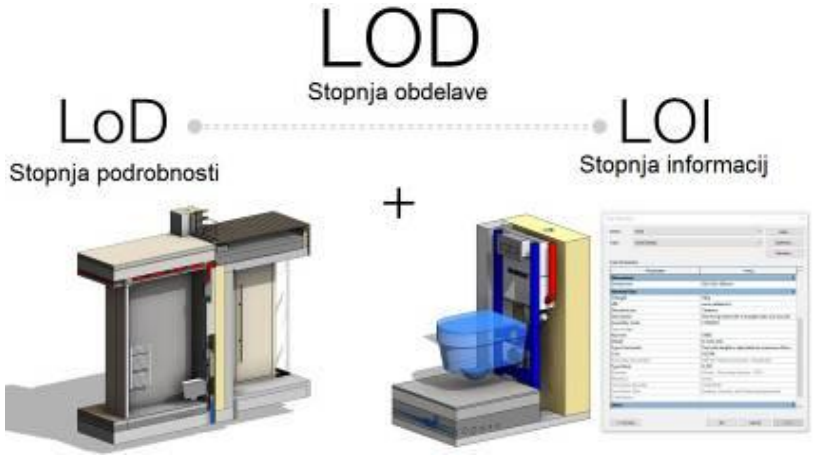
Vir:McPhee 2013.

Stopnja informacij LOI (ang. *Level of Information, LOI*) je opis *stopnje negrafične vsebine,* ki je dodana BIM-objektu, kot so npr. fizikalne lastnosti, kot so toplotna prevodnost, trdnost, požarna odpornost, standardi katerim objekti ustrezajo, proizvajalec, garancijski pogoji, intervali vzdrževanja itn. Običajno se informacija skozi razvoj projekta vedno bolj dopolnjuje vse do predaje projekta naročniku, kjer so podatki, ki so potrebni za obratovanje in vzdrževanje vgrajene opreme vnešeni v COBie format, kot tudi vsa potrebna dokumentacija, skupaj s povezavami do PDF priročnikov.

Na spletni strani arhitekturnega biroja Košorok Gartner lahko najdemo zapisano, da »LOD-e ne moremo direktno povezovati s posameznimi fazami projektiranja. Npr. idejna zasnova lahko vsebuje elemente iz LOD 100, LOD 200 ali celo LOD 300, PGD (projekt za pridobitev gradbenega dovoljenja) nekako ustreza specifikacijam LOD 300, PZI (projekt za izvedbo) ustreza LOD 350-400, PID (projekt izvedbenih del) pa LOD 500. Gre zgolj za specifikacije, zato je, v izogib različnim interpretacijam, z investitorjem potrebno dogovoriti točne zahteve, stopnjo detajliranja in vsebino ter količino vnešenih informacij BIM modela.« (Košorok Gartner 2015). Po drugi strani pa je mnenje McPhee: »Ko sem prvič pojasnjeval LOD direktorju (arhitektu), je bil njegov prvi odziv "torej praviš da je LOD enak kot faza projekta". Moja prva reakcija je bila "no, ja in ne". Toda ko sem bolje premislil o tem, sem sklenil da je.« (McPhee 2013). Na spletni strani podjetja Trimble, pa lahko na primer najdemo zapis Elliota: »LOD je opredeljena kot stopnja obdelave in stopnjo podrobnosti, obe kratici sta sprejemljiva.«, ki jih avtor nato združi v en sam LOD (Elliot 2017).

Definicija LOD, LoD in LOI so potrebne predvsem zaradi določanja minimalnih zahtev, ki jih naročnik postavi izvajalcu projekta, saj se stroški priprave in izvajanja projekta lahko bistveno spreminjajo s stopnjami, ki jih mora izvajalec pripraviti naročniku. Seveda so posledično tudi boljši končni rezultati pri uporabi analiz različnih BIM-razsežnosti. Ker je bistvo BIM-pristopa sodelovanje med deležniki, se po Phiriju BIM-pristop razlikuje od tradicionalnega pristopa po tem, da so udeleženci tradicionalnega projekta razmejevali medsebojno odgovornost tako, da so odgovarjali direktno samo naročniku projekta, k čemur se je prilagodil tudi razvoj prava in zakonov. Pri BIM-pristopu pa so udeleženci medsebojno povezani za doseganje ciljev, zato je potrebno postaviti jasne zakonske okvirje, ki omogočajo razmejitev odgovornosti udeležencev ter določiti stopnjo zanesljivosti pri kakovosti dobavljenih BIM-modelov, kar je še posebej pomembno pri parametričnih BIM-modelih, ki so v medsebojni soodvisnosti z BIM-modeli drugih udeležencev projekta (Phiri 2016, str.70). Slika 11 prikazuje medsebojni odnos med LOD, LoD in LOI.

Slika 11: Razmerja med LOD, LoD in LOI



Vir: Košorok Gartner 2015

3.2 Slabosti in ovire BIM-pristopa

Čeprav ima BIM-postopek veliko prednosti pred tradicionalnimi postopki izvajanja projektov, ki se bodo s časom še nadgrajevale, pa je potrebno omeniti tudi njegove slabosti in pomanjkljivosti, ki so jih različni avtorji opazili. Tako je Lockley v poročilu »BIM-stopnja 2 na preizkušnji« (ang. *Level 2 BIM on trial*) predstavil rezultate preizkusa in definiral tri skupine ovir, s katerimi se srečamo pri implementaciji BIM-postopka: *ljudi, procese in tehnologijo,* za uspešno implementacijo in izrabo BIM-procesa pa je potrebna sodelovanje med vsemi skupinami, saj je BIM-proces prepletenost vseh treh (Lockley 2015).

Podobno, kot je že ugotovil East pri oblikovanju COBie standarda, so do enakega zaključka prišli tako NBS in britanska vlada, kot Phiri, da je *največja ovira pri implementaciji in sprejetju BIM-pristopa* skozi celotno gradbeno industrijo *sprejetje in uveljavljanje s strani lastnikov,* zato je k cilju zavezano vodstvo projekta s strani naročnika identificirano kot pomemben faktor pri vpeljevanju in sprejetju BIM-pristopa (East 2007, str.5; Phiri 2016, str.40). Najboljši način za sprejetje (motečih) tehnologij, kot je BIM-pristop, je torej brezpogojna zahteva po implementaciji s strani naročnika projekta, kar je tudi temelj strategije vlade VB, ki je sprejela obvezno uporabo BIM-pristopa za sodelovanje na javnih naročilih

BIM-pristop zahteva sodelovalni pristop med deležniki, s čimer se podirajo sedanje, jasno definirane vloge in odgovornosti posameznika v tradicionalnih pristopih in jih iz vertikalne postavlja v horizontalno strukturo. Po Phiriju temelji filozofija BIM-pristopa na sodelovanju, transparentnosti in učinkovitosti ter *win-win* odnosu med deležniki, ki mora nadomestiti tradicionalne, dokaj sovražno nastrojene poslovne prakse, da bi dosegli sodelovalen pristop, ki bo gonilo napredka, to pa zahteva *spremembo kulture* (Phiri 2016, str.33).

Študija 408 projektov, skupaj ocenjenih na 559 milijonov dolarjev, ki jo je izvedel Cannistraro, kaže, da se s povečanjem sodelovanja in dviganjem stopenj BIM-postopka, skozi manjše število zahtevkov po spremembah zmanjšujejo tudi stroški projekta, potencialen prihranek pa je 20 % celotne investicije (Cannistraro 2010). Dassault Systems ugotavlja, da se gradbeni procesi v gradbeni industriji niso prilagodili BIM-postopku na pravilen način in so uspeli na BIM-stopnji 2 obdržati zaprtost znotraj posameznih oddelkov, »silosov«, kar pa preprečuje prehod na BIM-stopnjo 3. Vsaka skupina je tradicionalno opredeljevala "sodelovanje" drugače in se osredotočala na individualne ter lastne potrebe: konstrukcijski oddelek dojema sodelovanje, da delajo na enem BIM-modelu, nabavni oddelek dojema sodelovanje kot pregled izdelovalnih risb ali dokumentov drugih dobaviteljev, gradbeni oddelek pa dojema sodelovanje kot uporabo strukturiranega sistema managementa projektov. Oblikovali so se ustaljeni postopki predaje in morebitnih kasnejših poprav ter dodelav projektov, kar omogoča zaprtost oddelkov v posamezne »silose« in onemogoča integracijo med posameznimi oddelki ter tako zaklepa koristi in dodano vrednost znotraj posameznih silosov. Vse to rezultira v pomanjkljivi podatkovni integracije, nepovezani dokumentaciji in nezadostnih podatkih za relevantno 4D-BIM simulacijo procesov, ki so ključni vzroki za nepredviden rok končanja projekta (Dassault Systems 2016, str.3). Tako kot so ugotovili Gallaher in sodelavci, je Phiri podal mnenje, da je razlog tudi v dejstvu, da različni deležniki projekta redko sodelujejo skupaj na projektu več kot enkrat, zato ni dovolj časa, da bi se med njimi razvilo zaupanje, kar je posledično vodilo do oblikovanja kulture dela v »silosih« (Gallaher et al. NIST 2004, str.7-1; Phiri 2016, str.76).

Kot smo že spoznali na primeru Košorok Gartner, je potrebno obravnavati vidik *pomanjkanja pravnih okvirov za BIM-projekte,* ki preprečujejo širitev BIM-pristopa. Tradicionalni gradbeni projekti imajo informacije ločene po posameznih oddelkih, pravni okviri pa so se skozi desetletja razvila v skladu s tako organizacijsko strukturo in načinom izvajanja projektov. Danes je zato v tradicionalnih pristopih zakonsko povsem jasno opredeljeno, kdo poseduje kaj, kdo je pristojen za katero informacijo in je tudi odgovoren v primeru napak, ki se pojavijo. Zanesljivo upravljanje z informacijami ter sledljivi potek dela ustvarja odgovornost in posledično zmanjšuje pravna tveganja ter odškodninska zavarovanja. Leta 2010 je Carlin izpostavila, da je BIM-pristop v primerjavi z tradicionalnimi pristopi še relativno mlad, zato se je med deležniki projektov ustvarilo mnenje, da naj bi integracija informacij prinašala velike koristi predvsem za naročnika, tveganjem pa so izpostavljeni predvsem izvajalci (Carlin 2010). To mnenje lahko najdemo tudi leta 2015, kjer Mineer pravi, da pravne posledice uporabe BIM-postopka še niso bile obširno testirane, kaj šele usklajene (Mineer 2015). Kot opaža Phiri, se pri izvajanju projektov tudi sicer pogosto dogaja, da zaradi odprtih legalnih vprašanj, deležniki pričnejo dodajati svojim konstrukcijskim rešitvam, ki jih nato dodajo skupnemu BIM-modelu, opombe, kjer pravijo, da je njihov prispevek »samo informativne narave« in se nanj ne moremo popolnoma zanesti, kar pomeni, da do pravega deljenja informacij, kar pa je pravo bistvo BIM-postopka, ne prihaja (Phiri 2016, str.73). Če se želi to oviro odstraniti, je nujno potrebno odgovoriti na pomembna pravna in praktična vprašanja, ki zadevajo uporabe

terminologije, jurisdikcijo pristojnosti, potek delovnih tokov in managementa intelektualne lastnine, ki jih vpeljava nove in zato moteče tehnologije kot je BIM-pristop, zastavlja.

Razvoj IKT tehnologije je omogočil širitev in uveljavljanje BIM-pristopa, a ta odpira obenem tudi vrsto vprašanj. Tako recimo *IFC standardi še niso povsem definirani in popolna interoperabilnost še ni dosežena.* Trenutni IFC4-format ne podpira popolnoma infrastrukturne gradnje, temveč samo osi linijskih gradnikov (ceste, mostove, železnic, tunel), šele IFC5-format, ki je v razvoju, pa bo omogočal celovito podporo za infrastrukturno gradnjo, tako da bo dosežena interoperabilnost BIM-modelov tudi v drugih panogah gradnje (Liebich et al.b.l.; Nemec Pečjak 2017, str.49). Ravno tako se tudi še ni povsem poenotilo klasifikacij. Chapman izpostavlja, da ima Uniclass2 dodano klasifikacijo »delovni rezultati« (ang. *Work Results*), ki naj bi bila pomembna za managent projektov, saj vodi oceno opravljenega dela na posameznem elementu znotraj drugih klasifikacij in tako omogoča, da imamo samo v eni tabeli popoln pregled nad celotnim časovnim potekom projekta (Chapman 2013). Le ta je kasneje v Uniclass2 bila zaradi odvečnosti umaknjena, nato pa je sledilo še preimenovanje Uniclass2 v Uniclass2015 (Gelder 2014; McPhee 2015).

Sledeča ovira so *stroški investicij v novo tehnologijo*, ki se sestavljajo iz stroškov nakupa programov, nakupa sodobne strojne opreme ter šolanja kadra. Nadgradnja IKT-ja in programske opreme za vpeljevanje BIM-pristopa zahtevajo znatne naložbe. Kot ugotavlja Mineer, se naložba zaradi prednosti BIM-pristopa običajno splača, vendar le, če se programska oprema uporablja v njeni polno zmogljivosti (Mineer 2015). Zato, pravi Phiri, je potrebno definirati potrebe znotraj oddelkov organizacije in izbrati njim primerna orodja. Tako na primer, izvajalec gradnje, ki se ne ukvarja z s kompleksnim 4D-BIM ali 5D-BIM modeliranjem, potrebuje samo pregledovalnik (ang. *viewer*), medtem ko gradbeni nadzornik potrebuje programska orodja, ki omogočajo vnos zaključenih faz projekta ali porabljenih količin materiala (Phiri 2016, str.6).

Mineer izpostavlja tudi nevarnost nezdružljivosti z ostalimi deležniki projekta, ki BIM-pristopa še ne uporabljajo ali pa so ga pomanjkljivo vpeljali, saj BIM-pristop naj še ne bi bil splošno uporabljen v gradbeništvu, zato obstaja možnost, da eden od deležnikov ne bo uporabljal BIM-pristopa ali pa ne bo mogel uporabljati naših BIM-modelov (Mineer 2015). In če Mineer pravi, da se stroški izplačajo le, če se programska oprema uporablja v njeni polno zmogljivosti, ugotavljata O'Reilly in Clarkson, da *uporabniki BIM-pristopa pogosto ne uporabljajo vseh možnosti,* ki jih BIM-pristop ponuja in ne obravnavajo vseh zahtev, ki jih BIM-pristop potrebuje, temveč samo tiste, ki so najbolj očitne in jih je običajno najlažje doseči (O'Reilly & Clarkson 2016).

Seveda obstajajo tudi druga vprašanja in ovire, kot so npr. vprašanje varnosti in zlorab, ki jih predstavlja centraliziran BIM-model, pomanjkanje izkušenega in izšolanega kadra za management ter izvedbo BIM-projektov, vprašanja kakovosti BIM-modelov, podatkov in informacij, ki jih deležniki projekta uporabljajo in sooblikujejo z njimi oceno stroškov in časa celotnega projekta, aktivno vnašanje povratnih informacij, kjer beležimo odstopanja

med dejanskim in modeliranim stanjem. Vsa ta vprašanja so za to magistrsko delo preobsežna. Prispodoba ledene gore na Sliki 12 prikazuje pogosto spregledane in neuporabljene zmožnosti BIM-pristopa.

Slika 12: Uporabljene in spregledane zmožnosti BIM-pristopa

Vir: Revit 2018.

3.3 BIM-pristop v Veliki Britaniji in Sloveniji

V svetu se pri uveljavljanju BIM-pristopa ločijo trije načini implementacije, in sicer **od spodaj navzgor** (ang. *bottom-up*), **od zgoraj navzdol** (ang. *top-down*) ter **od sredine navzven** (ang. *middle-out*).

V *prvi skupini* so države skozi zakonodajo spodbudile implementacijo BIM-pristopa najprej v javnem in posledično tudi zasebnem sektorju. Dober zgled uveljavljanja BIM-pristopa je Singapur. Kot opisuje Lam, je leta 2010, podobno kot East v ZDA pri oblikovanju COBie standarda, vlada Singapurja identificirala pomanjkanje zahtev s strani lastnikov po uveljavitvi BIM-pristopa, zato so v svojem prvem načrtu, definirali kot prvi cilj prevzem pobude ter si zastavili vsakoletne mejnike pri implementaciji in difuziji preko javnega v zasebni sektor (Lam 2014). V poročilu McGraw-Hill iz leta 2014 je zavedeno, da je Singapur prvi na svetu vpeljal hitro izdajo dovoljenj na podlagi e-prijav BIM-modelov, ki so od leta 2015 obvezni za vse objekte večje od 5.000 m^2, tako za arhitekturne kot gradbene vloge (McGraw Hill 2014, str.24).

V Evropski unija se je leta 2016 ustanovila *EU BIM delovna skupina* (ang. *EU BIM Task Group*), ki naj bi ustanovila evropsko mrežo, njen namen pa je skupno usklajevanje članic pri uporabi BIM-pristopa v javnih naročilih. Kot navajajo na svoji spletni strani, so si za cilj zadali izdajo priročnika, ki naj vseboval izvajanje javnih naročil, tehnična priporočila, razvoj kulture in znanja ter koristi BIM-postopka in digitalnega poslovanja, namenjen oblikovalcem politik in javnim naročnikom (EU BIM Task Group b.l.).

V *drugi skupini* so države, kjer se je kljub odsotnosti vladnih programov k spodbujanju uvajanja BIM-pristopa, spontano oblikoval dovolj širok krog uporabnikov BIM-pristopa, ki so skupaj spodbudili visoko stopnjo implementacije BIM-pristopa, najprej v zasebnem in nato tudi javnem sektorju. Med te države štejemo predvsem skandinavske države. Kot omenja Singh, je bila na Švedskem implementacija BIM-pristopa bila tako obsežna, da so se pojavile najboljše prakse tudi v odsotnosti smernic vlad in da Švedska v publikaciji akademskih poročil na temo BIM-pristopa zaostaja le za ZDA (Singh 2017). Phiri izpostavlja, da so bile v skandinavskih državah mlajše generacije gonilo napredka, predvsem zaradi uporabe BIM-pristopa kot orodja za doseganje prihrankov na projektih (Phiri 2016, str.8). Construction Manager Magazine poroča, da so vse države na regijskem nivoju že uvedle pričakovanja glede BIM-pristopa, ki so pogosto bolj zahtevna glede interoperabilnosti od britanskih zahtev na BIM-stopnji 2, kar izvaja pritisk na lokalne ponudnike BIM-programov, kot so Eleco, Solibri in Tekla ter, da želijo po vzoru Singapurja avtomatizirati odobritev dovoljenje za gradnjo, čeprav ni trenutno vzpostavljen še noben podoben, delujoč sistem (Construction Manager Magazine 2015).

Kot opisuje spletna stran BIMThinkSpace pa naj bi se *tretja skupina,* od sredine navzven, skrivala vsem jasno na očeh in naj bi se pojavil v sredinskem, razmejitvenem prostoru med zgornjim, to je vlada in njeni upravni organi ter spodnjim nivojem, kjer se nahajajo majhna podjetja, podizvajalci in dobavitelji, sočasno pa zaradi konkurenčnosti prevzemajo BIM-postopek tudi podjetja in organizacije na horizontalni ravni (BIMThinkSpace 2014). Gre za srednje velike organizacije ali linijske in projektne managerje, ki začnejo za uveljavitev BIM-pristopa izvajati pritisk tako proti vrhu kot tudi proti nižjim nivojem.

Kassem in Succar sta v raziskavi o načinu prevzemanja BIM-postopka države razvrstila v Tabelo 1.

Tabela 1: *Razvrstitev držav glede na način prevzemanja BIM-postopka*

država	Finska	Hong Kong	Kanada	Kitajska	Nova Zelandija	Španija	Švica	ZAE	VB	ZDA
od zgoraj navzdol		x						x	x	
od sredine navzven	x		x	x			x			x
od spodaj navzgor					x	x				

Vir: Kassem, Succar 2017.

3.3.1 Velika Britanija

Velika Britanija torej spada v skupino držav, kjer se je uporabil pristop implementacije BIM-pristopa od zgoraj navzdol. Obstaja splošno prepričanje, da je strategija VB dober zgled, kako se pravilno lotiti takega pristopa implementacije. Kot meni na primer Evropska investicijska banka, BIM omogoča popolno realizacijo potenciala digitalne tehnologije v gradbeništvu in grajenem okolju ter ga prepoznava kot tehnologijo, ki bo temeljito spremenila način izvajanja gradbenih projektov in bo implementirana globalno, trenutno pa je VB vodilna v svetu (EIB 2018, str.209). Phiri tako pravi, da več držav opazuje, kako je VB implementirala BIM-pristopa in koristi¸ ki jih ima skozi konstrukcijo, gradnjo in celotnim življenjskim ciklom objekta (Phiri 2016, str.7). Na spletni strani enega vodilnih razvijalcev BIM-programov, pa je Duncan zapisal, da je vlada VB leta 2011 začela širokopotezen načrt uvajanja BIM-pristopa, ki je še danes edinstven v svetu (Duncan R., b.l.).

Začetni korak k vpeljavi BIM-pristopa v javni sektor predstavlja *Vladna strategija v gradbeništvu* (ang. *Government Construction Strategy*), sprejeta maja 2011. V njej je prepoznana izjemna pomembnost vpliva učinkovitosti gradbene industrije na ekonomijo VB, saj predstavlja gradbeni sektor 110 milijard funtov letnega prometa, kar je več kot avtomobilska, energetska in aeronavtična sektorji skupaj, od tega pa predstavljajo javna naročila 40 % delež, s čimer je vlada VB največji naročnik (Government Construction Strategy 2011, str.3). Ker pa je vlada ugotovila, da obstaja široko razširjeno prepričanje, da kot naročniki ne dobijo polne vrednosti ter ne stimulirajo rasti v gradbeništvu, je sprejela podroben program ukrepov, namenjenih k zmanjšanju stroškov za 20 % do konca vlade (ta je bila izvoljena 2010). Ukrepi naj bi prisilili deležnike k spremembi poslovnih običajev in praks od sovražnih k sodelovalnim, če bodo hoteli doseči zmanjšanje stroškov, predvsem skozi inovativnost znotraj verige dobaviteljev ter si tako zagotoviti konkurenčno pozicijo tudi v prihodnosti. Kot zgledna javna naročila pa naj bi bila tista v katerem (Government Construction Strategy 2011, str.3):

- naročnik izda navodila, ki se osredotočajo na zahtevane zmogljivosti in končne rezultate, načrtovalci in konstruktorji pa s skupnimi močmi razvijejo integrirano rešitev, ki najbolje ustreza zahtevanim rezultatom;
- izvajalci vključijo ključne člene svoje dobavne verige v proces načrtovanja, kjer lahko njihov prispevek največ doprinese k ustvarjanju dodatne vrednosti;
- cenovna učinkovitost in konkurenčna napetost se vzdržujeta z učinkovito cenovno primerjavo in natančnemu opredeljevanju stroškov, tako da je znano, koliko bi morali projekti stati, namesto da se ocenjuje preko razpisov pavšalnih zneskov na podlagi nepopolne dokumentacije;
- dobavne verige so, kjer je program naročanja primeren, vključene na osnovi rednih naročil, ki so v zadostnem obsegu in trajanju, da se lahko spodbudijo raziskave in inovacije okoli standardiziranega (ali po meri narejenega) izdelka;

- industrija ima dovolj jasen vpogled v prihodnje programe vladnih vlaganj in investicij, da se lahko preudarno in na lastno odgovornost odločajo o tem, kje in kako bodo vlagali v razvoj izdelkov, storitev, tehnologije in znanja; ter
- gre za uskladitev interesov med tistimi, ki načrtujejo in zgradijo gradnjo in tistimi, ki jo nato uporabljajo in upravljajo.

Vlada kasneje v dokumentu prepozna prednosti BIM-pristopa, ki naj bi ga uporabljala najnaprednejša podjetja, katera so zmožna delovati v popolnoma sodelovalnem 3D-okolju, z vsemi projektnimi in premoženjskimi informacijami, dokumentacijo in podatki v elektronski obliki, tako da vsi deležniki delajo na enotni platformi z zmanjšanimi transakcijskimi stroški in možnostmi za napake, a da je žal panoga v splošnem zaostajala pri izkoriščanju prednosti, ki jih omogoča digitalna tehnologija. Zaradi pomanjkanja interoperabilnosti in različnih interesov med udeleženci naj bi se onemogočala splošna implementacija BIM-pristopa v gradbeništvu, zato se je vlada odločila osnovati uradni kabinet, ki bo zadolžen za koordinacijo pri postopnem uvajanje BIM-pristopa, tako da bo dosežen cilj, ki je polno sodelovalen 3D-BIM, kot nujen pogoj za možnost sodelovanja pri vseh javnih gradbenih naročilih od leta 2016 dalje (Government Construction Strategy 2011, str.13). Vladni dokument torej definira, čeprav izrecno ne omenja, zahtevo po implementaciji BIM-stopnje 2 v gradbenem sektorju, s pomočjo vladnega programa, ki bo organizacijam pomagal pri postopni vpeljavi novega pristopa izvajanja projektov. Po podatkih v poročilu naj bi v gradbenem sektorju delovalo 300.000 podjetij, od tega 99,7 % srednje velikih in majhnih podjetij, skupaj pa naj bi zaposlovali preko 2.000.000 ljudi (Government Construction Strategy 2011, str.5). Prav tako vladni kabinet ustanovi **BIM Task Group**, ki je zadolžen za doseganje cilja pri implementaciji BIM-pristopa.

Istega leta izvede **Nacionalni odbor za gradbeno specifikacijo** (ang. *National Building Specification, v nadaljevanju NBS*) tudi prvo anketo, da bi ocenili kakšno je stanje v gradbeništvu in kako velik razkorak je med izhodiščnim, trenutnim stanjem ter končnim ciljem. Na spletno anketo je odgovorilo 400 anketirancev, rezultati pa so pokazali, da samo 13 % anketirancev uporablja BIM-pristop, 43 % pa BIM-pristopa sploh ni poznalo. Poleg tega jih je kar 42 % še vedno risalo na tablo, kar po definiciji BIM-stopenj sploh nima nobene zrelostne stopnje, 33 % pa jih je uporabljalo zgolj 2D-CAD risbe, kar se uvršča v zrelostno BIM-stopnjo 0 (NBS 2011, str.8).

Leta 2012 izda vlada VB dokument *Informacijsko modeliranje gradenj* (ang. *Building Information Modelling*), kjer ovrednoti zmožnosti, ki jih omogoča BIM-pristopa. V njem opredelijo kot glavni, dolgoročni cilj ambicijo postati svetovni voditelj v izkoriščanju BIM-pristopa in preko razvijanja lastnih zmožnosti zrasti tudi kot glavni svetovni dobavitelj BIM-storitev in programov. Za realizacijo tega cilja si zastavijo 3 delni načrt (Building Information Modelling 2012, str.5):

1. popolna zaveza k obstoječim BIM-programom za ustvarjanje kritične mase,
2. usmerjenost na rast (BIM-postopek kot pogon rasti),

3. pomagati ustvarjati prihodnost z nenehnim razvojem lastnih sposobnosti.

Naslednjega leta 2013 je vlada izdala poročilo *Gradnja 2025* (ang. *Construction 2025***)**, v kateri je skupaj z predstavniki gradbene industrije definirala nove cilje, ki naj bi jih dosegli do leta 2025 (Construction 2025 2013, str.19):

- 33 % zmanjšanje tako začetnih stroškov gradnje kot tudi celotnih stroškov skozi življenjsko dobo zgrajenih sredstev;
- 50 % skrajšanje časa od osnutka do dokončanja, tako za novogradnje kot prenovo gradenj;
- 50 % zmanjšanje emisij toplogrednih plinov v grajenem okolju;
- 50 % zmanjšanje razlike v trgovinski izmenjavi, med celotnim izvozom in uvozom gradbenih izdelkov in materialov.

Istega leta je bila izvedena prva mednarodna raziskava o uveljavitvi BIM-pristopa, ki jo je NBS izvedel na Finskem, Kanadi in Novi Zelandiji. Raziskava je pokazala visoko stopnjo seznanjenosti anketirancev z BIM-postopkom v vseh državah, ki je bila nad 87 %, medtem ko je bila VB po uporabi BIM-pristopa na zadnjem mestu s samo 39 %, sledila ji je Nova Zelandija s 57 %, Kanada s 64 % in Finska na 1. mestu s 65 % deležem uporabnikov BIM-postopka (NBS International BIM Report 2013, str.6).

Prav tako je bila izvedena nacionalna anketna raziskava, na katero je odgovorilo 1000 anketirancev, rezultati pa so objavljeni v poročilu NBS 2014. Delež anketirancev, ki ne poznajo in ne uporabljajo BIM-pristopa se je zmanjšal iz 43 % iz leta 2011 na 5 %, delež tistih, ki BIM-pristop poznajo in uporabljajo pa se je dvignil iz 13 % leta 2011 na 54 % (NBS National BIM Report 2014, str.12). Če primerjamo rezultate mednarodne raziskave iz leta 2013 in nacionalne ankete leta 2014, zaznamo 15 % rast uporabnikov BIM-pristopa.

Leta 2015 je vlada izdala dokument *Digitalno grajena Britanija* (ang. *Digital Built Britain*), ki predvideva vpeljavo BIM-stopnje 3 in je nadgradnja treh strategij, in sicer Gradnja 2025 (ang. *Construction 2025*), Pametno mesto (ang. *Smart City*) in Digitalna ekonomija (ang. *Digital Economy*). V dokumentu se predpostavlja, da bo povečanje populacije in demografske spremembe (zlasti staranje prebivalstva) močno obremenilo obstoječe grajeno okolje in storitve, ki jih zagotavlja, kar bo še dodatno omejilo gospodarsko rast (Sielker, Allmendinger, 2018). Kot kompenzacija tem negativnim učinkom, pa bo BIM-pristop v naslednjem desetletju pripeljal do združenja z internetom stvari (ang. *internet of things*), naprednimi podatkovnimi analizami velikih baz podatkov (ang. *big data*) in digitalno ekonomijo, združitev pa bo omogočala učinkovitejše načrtovanje in vzdrževanje nove infrastrukture ter gradnjo ob nižjih stroških, ki bo kasneje *osnova za BIM-stopnjo 4*, ki ima poudarek na doseganju ugodnih družbenih rezultatov in dobro počutje prebivalcev (Digital Built Britain 2015, str.5, str.15).

Pri doseganju BIM-stopnje 3 so v poročilu opisane 4 faze za doseganje tržnih priložnosti (Digital Built Britain 2015, str.21):

- Stopnja 3A, ki omogoča izboljšave v modelu stopnje 2,
- Stopnja 3B, ki omogoča uporabo novih tehnologij in sistemov,
- Stopnja 3C, ki omogoča razvoj novih poslovnih modelov,
- Stopnja 3D, izkoristiti vodilno vlogo v svetu.

Kritik te strategije je Klaschka, cenjen zagovornik BIM-pristopa iz arhitekturnega biroja Klaschka Studios, ki meni, da tako programska oprema kot tehnološki razvoj še nista dovolj razvita, da bi lahko razpravljali o BIM-stopnji 3, medtem ko pri uveljavljanju BIM-stopnje 2 to niso bile ovire (Knutt 2015).

Tega leta je, tako kot Slovenija, tudi VB prenesla direktivo 2014/24/EU v lasten zakon o javnih naročilih (ang. *the public contracts regulations 2015*), ki je stopil v veljavo aprila 2015 in ima enako vlogo kot slovenski zakon o javnih naročilih ZJN-3 (Mills & Reeve 2015, str.3). Torej bi lahko sklepali, da uveljavitev zahteve po obvezni uporabi BIM-pristopa za javna naročila ni v nasprotju z evropsko zakonodajo.

Izsledki nacionalne ankete iz tega leta pokažejo, da je 54 % respodentov na nacionalni anketi uporabljalo BIM-pristop, kar je enak delež kot iz poročila iz leta 2014 (NBS 2016, str.16). Mednarodna raziskava, pa je pri uporabi BIM-pristopa postavila Češko na zadnje mesto s 25 %, Japonsko na predzadnje mesto s 46 %, VB na 3. mesto z 48 %, Kanado na 2. mesto s 67 % in Dansko na prvo mesto z 78 % (NBS 2016, str.7).

Naslednja *Vladna strategija VB v gradbeništvu 2016-2020* (ang. *Government Construction Strategy 2016-2020*) je bila sprejeta 2016 in je zajeta v 6-ih ključnih točkah (Government Construction Strategy 2016):

1. *koordinacija in vodenje* znotraj vladnih strank za zagotovitev koherentnega in konsistentnega pristopa do javnih naročil;
2. *izboljšanje sposobnosti stranke*, to je centralne vlade, da se odziva na pravi način in s tem pridobi kar največ od izvajalcev;
3. *izboljšanje izrabe podatkov*, merjenje in poročanje o napredku strategije, merjenje razvoja vajeništva skozi javna naročila, uporaba podatkov za identifikacijo najboljših praks, razvoj podatkovnih zahtev za merjenje stroškov skozi celotno življenje gradenj in oddajanje ogljika, sporočanje prihodnjih javnih naročil
4. *komunikacija* za dviganje ozaveščenosti v gradbeništvu o ciljih vlade in sporočanje najboljših praks,
5. *zaključitev uvajanja BIM-stopnje 2* in sporočanje najboljših praks, razvoj zrelosti implementacije BIM-stopnje 2 do te mere, da se lahko prične z uvajanjem BIM-stopnje 3;

6. *sodelovalno izvajanje naročil*, kar pomeni podpreti sprejetje Projektnih bančnih računov, za direktno in sočasno izplačilo vseh deležnikov projekta iz enega centralnega bančnega računa, nadzor teh računov ter voditi koordiniran pristop do izvajanja naročil skupaj z izdelavo delovnega okvirja, načina izvajanja in sporočanja najboljših praks.

Čeprav niso zmanjšali stroškov naročil za gradnje za 20 %, kot so načrtovali v prvi strategiji, kar je pomenilo za 8,8 milijarde prihrankov (leta 2010 je bilo za 110 milijard naročil, od tega so javna naročila predstavljala 40 %), pa so prihranili 3 milijarde funtov med leti 2011 in 2015, poroča spletna stran Designing Buildings (Designing Buildings 2017). V novi strategiji so si zadali prihranitev 1,7 milijarde funtov med leti 2016 in 2020 ter izvedbo 20.000 vajeniških delovnih mest. Mills na spletni stran B1M razlaga, da se je izkazal problem prenašanja finančnih bremen in tveganj iz večjih izvajalcev na podizvajalce, običajno srednje velika in majhna podjetja, zato je vlada pripravila projektne bančne račune, da bi zajezila nepoštene plačilne postopke, zagotovila transparentnost in gotovost plačil, zmanjšala potrebe po zadolževanju, da bi tako ustvarila bolj uravnoteženo poslovno okolje, ki bo v zameno spodbujalo rast (Mills 2016).

V letu 2016 se je zaradi preusmeritve pozornosti BIM Task Group-a na implementacijo BIM-stopnje 3 in možnosti, da nastane vrzel pri nadaljevanju implementacije BIM-stopnje 2, oblikovalo *VB BIM zavezništvo* (ang. *UK BIM Alliance*), ki v svojem poročilu trdi, da je recesija v gradbeništvu spodbudila zanimanje za implementacijo BIM-stopnje 2 s strani izvajalcev, ki bi jo sicer odložili na prihodnost, a da ostaja velik del tistih, ki so skeptični ali brezbrižni do koristi in nimajo dolgoročne zavezanosti do BIM-pristopa ter k digitalnemu sodelovanju (UK BIM Alliance 2016, str.10). Eden izmed razlogov navajajo majhen dobiček, ki so ga v dobavni verigi deležni, zato nekateri s težavo upravičijo stroške investicij v nove tehnologije in orodja, če nimajo dolgoročnih naročil (UK BIM Alliance 2016, str.14).

Poročilo o nacionalni anketi izdano v letu 2017, na katero je odgovorilo več kot 1000 anketirancev je, po enem letu vpeljave obveznega BIM-pristopa za vsa javna naročila, pokazalo sledeče rezultate (Malleson 2017, str.12):

- 97 % je BIM-pristop poznala (poročilo iz leta 2011 navaja 58 %),
- 51 % anketirancev meni, da je vlada VB na pravi poti pri vpeljavi BIM-pristopa,
- 37 % jih še vedno ne ve, kaj morajo storiti, da ugodijo zahtevam vlade pri BIM-pristopu, med njimi pa so tudi vladni oddelki, zadolženi za izvajanje vpeljave,
- 19 % jih je menilo, da je VB svetovni voditelj, obenem pa se Malleson iz NBS sprašuje, če to ne nakazuje na dejstvo, da si je vlada zadala previsoke cilje,
- v letu 2016 je uporabljalo BIM-pristop 63 %, v letu 2017 pa naj bi jih skupno 90 %,
- 42 % jih je generiralo COBie format za naročnika, kot najbolj pogost razlog negeneriranja pa je pomanjkanje zahteve s strani naročnika,

- 78 % je mnenja, da je BIM-pristop prihodnost projektnih informacij,
- 72 % pravi, da naročniki projektov ne razumejo prednosti BIM-pristopa.

Švedska spletna stran memoori je zato, glede na rezultate zadnje ankete, izrazila sledeče dvome o vpeljavi BIM-pristopa v VB: »Torej je VB svetovni voditelj v BIM-pristopu ali ne? In zakaj so si mnenja o tem tako nasprotna? Ali je možno, da VB poskuša biti vodja, a so pričakovanja prevelika za vpeljavo postopka, ki zajema zelo zahtevne tehnologije in procese? Če industrija pričakuje, da se bo to zgodilo čez noč, ali ni potem VB na poti vpeljave BIM-postopka dlje kot drugi države?« (memoori 2017).

3.3.2 Slovenija

Leta 2011 je Todorovič zapisal sledeč komentar o stanju BIM-pristopa: »Pri nas je trenutno žal uporaba informacijskih modelov še neznatna, zato je priporočljivo, da se upošteva izkušnje iz tujine in se gradi na tem, saj bomo edino tako lahko šli v korak s časom, ki ga narekuje sodobno gradbeništvo.« (Todorovič 2011, str.48).

V Tabeli 2 je Slovenija po raziskavi, ki so jo izvedli Carneiro, Lins in Neto, že v letih 2010 in 2011 zasedla 7. mesto na svetu, po številu akademskih strokovnih člankov na temo BIM-pristopa in si ga delila s Švedsko, najbolj plodna avtorja v svetovnem merilu pa sta bila slovenski avtor Cerovšek iz FGG-ja ter ameriški avtor Raja R. A. Issa s floridske univerze (Carneiro et. al, str.5).

Tabela 2: Države z največjim številom akademskih člankov na temo BIM-pristopa

Institucije	**% od vseh publikacij**
Univerzitetni park (ZDA)	4,5
Univerza Virginia Tech (ZDA)	3,75
Danska tehniška univerza (Danska)	3,28
Univerza v Newcastlu (Avstralija)	2,87
Tehnološki institut Georgia (ZDA)	2,78
Univerza na Floridi (ZDA)	2,59
Univerza v Ljubljani (Slovenija)	2,46
Univerza v Lundu (Švedska)	2,46
Nizozemska organizacija za uporabne znanstvene raziskave TNO (Nizozemska)	2,42
Raziskovalni in razvojni center vojaških inženirjev Združenih držav Amerike (ZDA)	1,94
Druge inštitucije	68,17
Ni določeno	2,78
Skupaj	100

Vir: Carneiro, Lins in Neto 2011, str.6.

Tako se v raziskavi Slovenija nahaja med državami, ki vpeljujejo BIM-pristop v procese javnega naročanja. Leta 2010 je Cerovšek v članku Informacijsko modeliranje zgradb

(BIM) zapisal: »Če primerjamo podoben dogodek, ki smo ga organizirali na Univerzi v Ljubljani leta 2006, lahko sklepamo, da je čas za uvajanje BIM v slovensko gradbeništvo sedaj zrel in nujen.« (Cerovšek 2010, str.72). Pri tem se lahko upravičeno vprašamo, kakšno je potem stanje implementacije BIM-pristopa v Sloveniji?

Na spletni strani Ministrstva za javno upravo je zapisano: »V Sloveniji sistem javnega naročanja urejajo Zakon o javnem naročanju (ZJN), Zakon o javnem naročanju na področju obrambe in varnosti (ZJNPOV), Zakon o pravnem varstvu v postopkih javnega naročanja (ZPVPJN) in njihovi podzakonski akti.« Do 1.aprila 2016 pa je bil v veljavi tudi Zakon o javnem naročanju na vodnem, energetskem, transportnem področju in področju poštnih storitev (ZJNVETPS), ki je z uveljavitvijo **ZJN-3** prenehal veljati.

Na spletni strani Statist, najdemo podatke, da je bila med letoma 2013 in 2016 skupna vrednost javnih naročil 7,9 milijarde evrov, od tega je bilo za gradnjo namenjeno 3,5 milijarde, kar predstavlja 44 % celotne vrednosti javnih naročil, 94 % vseh naročil za gradnjo pa je bilo razpisanih po ZJN-2 in ZJN-3, kot je tudi prikazano v Tabeli 3 (Statist 2017). V članku časnika Delo, je Gole zapisal, da aplikacija Statist še ne vključuje naročil brez davka na dodano vrednost do 40.000 evrov za gradnje ter do 20.000 evrov za blago in storitve, saj se ta ne objavljajo, ampak naročniki o njih enkrat letno poročajo (Gole 2016).

Tabela 3: V*rednost javnih in gradbenih naročil med leti 2013 in 2016*

leto	**št. podjetij**	**vrednost vseh javnih naročil (€)**	**vrednost javnih gradbenih naročil (€)**	**delež %**
2013	39.516	2.294.022.417	1.479.325.722	64 %
2014	39.191	1.826.647.943	981.096.564	54 %
2015	38.622	1.678.556.101	499.562.076	30 %
2016	37.925	2.139.999.351	532.650.195	25 %
skupaj	/	7.939.225.812	3.492.634.557	44 %

Vir: statist b.l..

ZJN-3, ki torej nosi bistveni delež javnih naročil, je v slovensko zakonodajo prišel z zavezo pri direktivi 2014/24/EU. Kot navaja Evropska komisija, je bila direktiva spisana, da bi omogočila večjo možnost izkoriščanja prednosti digitalne tehnologije, zmanjšati birokratizacijo in narediti postopke javnega naročanja bolj učinkovite ter vzpostaviti ugodno poslovno okolje (European Commission 2017). Direktiva ima v 22. členu 4 odstavka tudi zapisano, da za javna naročila gradenj in projektne natečaje lahko države članice zahtevajo uporabo točno določenih elektronskih orodij, kot je npr. informacijsko modeliranje gradenj ali podobna orodja (EUR-Lex 2014).

Po vpeljavi ZJN-3 je na spletni strani Uradnega lista Potočnikova med drugim izpostavila, da bo *vsa korespondenca* med naročnikom in ponudniki potekala izključno *z elektronskimi sredstvi* in ne več po navadni pošti, kar spominja na možnost uporabe BIM-postopka zaradi interoperabilnosti ter da bo *merilo najnižje cene ukinjeno* in nadomeščeno z merilom

ekonomsko najugodnejše ponudbe, kar je tudi eden izmed aspektov pri uporabi BIM-pristopa, saj se omogoča optimiranje ravnovesja med izvedbeno ceno in kakovostjo dolgoročnih rešitev (Potočnik 2014).

V ZJN-3 lahko poleg tega v 85. členu, o izračunu stroškov v življenjski dobi, najdemo sledeči zapis, ki bi lahko dogovarjal vsem razsežnostim BIM-pristopa (PIS 2015):

1. Izračun stroškov v življenjski dobi v ustreznem obsegu zajema vse ali del naslednjih stroškov v življenjski dobi blaga, storitve ali gradnje:
   a) stroške naročnika ali drugih uporabnikov, kot so:
      - stroški, povezani s pridobitvijo;
      - stroški uporabe, kot je poraba energije in drugih virov;
      - stroški vzdrževanja;
      - stroški, povezani s koncem življenjske dobe, kot so stroški zbiranja in recikliranja;
   b) stroške iz naslova zunanjih okoljskih vplivov, povezanih z življenjsko dobo blaga, storitve ali gradnje, če je mogoče določiti in preveriti njihovo denarno vrednost. Ti stroški lahko vključujejo stroške izpustov toplogrednih plinov in drugih onesnaževal ter druge stroške blažitve podnebnih sprememb,

Kot pravi IZS: »Če za izračun stroškov v življenjski dobi ni na voljo skupne metode EU, se lahko taka metoda določi na nacionalni, regionalni ali lokalni ravni. Metoda mora biti splošna in nediskriminatorna, torej ne izključno namenjena posebnemu postopku javnega naročila ter objektivna, zahtevane podatke pa mora podjetje zagotoviti z razumnim prizadevanjem.« , kar nakazuje prenos tudi 22. člena iz direktivi 2014/24/EU in možnost izbire BIM-pristopa za izračun stroškov kot zakonito in legitimno možnost (IZS 2016).

Na spletni strani e-naročanje je objavljeno, da je pri razpisu DARS-a za izvedbo drugega predora Karavanke, navedena kot temeljna zahteva uporaba BIM-pristopa na BIM-stopnji 2 in izdelava 3D, 4D, 5D in 6D BIM-modelov (enaročanje 2017).

Kljub temu, da ZJN-3 dopušča možnost uporabe BIM metode, pa lahko v slovenski zakonodaji in predpisih najdemo BIM-pristop omenjen samo v dokumentu **»Smernice za javno naročanje arhitekturnih in inženirskih storitev«**, in sicer pod točko 4.1 Tehnične specifikacije oz. projektna naloga. Na strani 13 je zapisano, da: »naročnik v tehničnih specifikacijah zasleduje cilj, da čim bolj natančno opredeli svoje zahteve glede prostorske umeščenosti, velikosti, namembnosti, funkcionalnosti, energetske učinkovitosti, okoljske sprejemljivosti, trajnosti, stroškovnih in vseh drugih vidikov v zvezi z gradnjo, ki je predmet arhitekturnih in inženirskih storitev,« kar prav tako spominja na BIM-razsežnosti, pod sestavine tehnične specifikacije pa je naveden »opis posebnih metodologij dela in načinov sodelovanja med udeleženci v postopku graditve, kot je na primer BIM (ang. *Building Information Modeling*) ipd.« (Ministrstvo za javno upravo 2016, str.13).

Nemec Pečjak ugotavlja, da so v smernicah nato izključene zahteve za 5D in 6D BIM, saj je na strani 14 smernic zapisano: »*Najbolj pravilen način upoštevanja trajnostne gradnje in zelenega javnega naročanja je, da se tovrstne zahteve vključijo med pogoje javnega naročila in ne med merila, na osnovi katerih se izbira najugodnejša ponudba arhitekturnih oz. inženirskih storitev.*

Uvrščanje zahtev glede trajnostne gradnje in zelenega javnega naročanja med merila ni priporočljivo in predstavlja izrazito zahtevno nalogo, saj je o količinah in LCC (*ang. Life Cycle Costs*) *lastnostih materialov oz. opreme na začetku investicije zelo težko natančno govoriti* (*projektne rešitve v času javnega naročila še ne obstajajo, prav tako tudi ne projektantski popisi, materiali imajo pomanjkljivo opredeljene faktorje LCC itd.*). *Bolj smotrno je ravnanje naročnika, da predvidi sistem nagrajevanja, če izbrani ponudnik v okviru izvedbe javnega naročila preseže zahteve naročnika v zvezi z energetsko učinkovitostjo in drugimi trajnostnimi vidiki v celotni življenjski dobi predmetnega objekta, seveda pod pogojem, da pri tem ne preseže zahtevano investicijsko vrednost gradnje.*« (Nemec Pečjak 2017, str.38).

Torej, če naročnik ne zahteva generiranja BIM-modela in COBie formata, se na dolgi rok ne more pričakovati oblikovanja baze podatkov, kjer bi skozi življenjsko dobo objekta dobili povratne informacije, s katerimi bi lahko analizirali povezavo med ogljičnim odtisom in tehničnimi karakteristikami vgrajenih materialov ter opreme in bi služila kot temelj za prihodnje natančne ocene pri izvajanju trajnostnih gradenj in zelenih javnih naročil.

Leta 2015 se je ustanovilo združenje **siBIM** (Slovensko združenje za informacijsko modeliranje v gradbeništvu). Na spletni strani združenja lahko najdemo, da je organizacija prostovoljna, samostojna nestrankarska, neprofitna, torej ni del državne pobude, a da je eden izmed ciljev: »Sodelovanje pri pripravi smernic in predpisov na področju informacijskega modeliranja grajenega okolja.«. Leta 2016 je združenje postalo član EU BIM Task Group-a, ki ima prav tako namen izdelave priročnika za potrebe državnih organov pri uvajanju BIM-postopka (siBIM b.l.).

Na spletni strani je predstavljenih tudi nekaj podjetij, ki pri svojem delu aktivno uporabljajo BIM-pristop in projektov, ki so bili izpeljani z BIM-pristopom:

- DRI upravljanje investicij, d.o.o., katere ustanovitelj je Republika Slovenija in je največje inženirsko in svetovalno podjetje v Sloveniji, ki izvaja projekte kot so drugi tunel karavanškega predora ter 3. razvojno os;
- Lineal d.o.o. na spletni strani izpostavlja uporabo BIM-pristopa kot ključno pri doseganju zastavljenih projektnih ciljev, večina projektov, ki so jih izvajajo pa so povezani z izgradnjo ali obnovo avtocest, katerih naročnik je DARS d.d., ki je v 100 % lasti Republike Slovenije (Lineal b.l.);

- razgledni stolp Vinarium, je eden izmed prvih javnih investicij v kateri je investitor, to je Občina Lendava, zahteval tudi izdelavo BIM-modela (siBIM b.l.).

V združenje je včlanjenih 95 članov in 30 simpatizerjev, na spletni strani Statističnega urada pa najdemo podatek, da je bilo leta 2015 v gradbeništvu registriranih skupaj 38.622 podjetij (si-stat b.l.). Potrebno je tudi upoštevati, da v BIM-pristopu participirajo tudi druge stroke, ki niso kvalificirana kot gradbena podjetja (strojna, ekonomska, komunikacijska, pravna, …) a jih BIM-pristop nujno potrebuje.

Tibaut, predsednik združenja siBIM je na BIM Akademiji leta 2016 izpostavil, da v Sloveniji ni jasno opredeljenih ciljev BIM-pristopa ali dobro definiranih nivojev implementacije in strateških mejnikov za BIM, ter da primanjkuje navodil, smernic, kot so slovenski klasifikacijski sistem za elemente in sisteme grajenega okolja (kot npr. OmniClass/USA, Uniclass/UK) ter smernic za vgraditev BIM-pristopa v (javne) razpise in projektne naloge (Tibaut 2016, str.6 in 9).

Do podobne ugotovitve, kot jo je zapisal UK BIM Alliance in Tibaut je prišel tudi Granda, ki meni, da je gradbena industrija v Sloveniji že nekaj let v zastoju, zato bi ta čas veljalo izkoristiti za nadgradnjo v BIM-pristop, saj ekonomski kazalci kažejo na ponovno rast gospodarstva, ki bo končala krizo tudi v gradbenem sektorju, zato bo v prednosti tisti, ki bo delal z BIM-pristopom že na začetku ponovne rasti (Granda 2015).

4 REZULTATI EMPIRIČNE RAZISKAVE

4.1 Empirična preverba uporabe BIM-pristopa v Sloveniji

Za podlago moje raziskave so bile izbrane ankete NBS. Kot že omenjeno v poglavju 3.3.1, je NBS leta 2010 izvedel prvo anketo, namenjeno oceni stanja BIM-pristopa v gradbeništvu in kako velik razkorak je med izhodiščnim stanjem ter končnim ciljem, le-te pa so bile redno izvajane vsako leto. Rezultate raziskav je možno primerjati iz leta v leto, vprašanja so osredotočena samo na eno temo in tržišče ter manj podrobna. Program vpeljave BIM-pristopa v javni in zasebno sektor VB je zelo obširen in deluje tudi na področju informiranja, šolanja ter podpore tako izvajalcem kot naročnikom.

Pri pripravi moje ankete sem najprej zbral vsa vprašanja iz vseh let raziskav, ki jih je NBS izvedel med leti 2011 in 2016. Nekatera vprašanja so bila enaka iz leta v leto, nekatera so se nadomestila, saj so bili rezultati konsistentni in ni bilo potrebe po ponovitvi vprašanj, nekatera dodatna vprašanja pa so se pojavila samo v enem letu in so povpraševala po točno določeni tematiki. Iz izbora vprašanj sem najprej izločil vsa tista, ki so bila specifična za britansko poslovno in zakonodajno okolje ter zato ne bi dala v slovenskem okolju relevantnih odgovorov. Sledeči kriterij je bila časovna omejitev vprašalnika, zato sem izločil skoraj vsa vprašanja, ki so se v anketa pojavila samo enkrat in niso kazala spreminjanje mnenja anketirancev skozi leta. V sodelovanju s predsednikom društva siBIM sem dodal vprašanje 9, »Kako dobro poznate BIM?«, ki nagovarja samo poznavalce

BIM-pristopa ter podaja sliko tudi zunaj kroga uporabnikov, vprašanje 11, »Katerega od naštetih sestavin BIM-pristopa uporablja vaša organizacija?«, ki je nadomestilo vprašanje o uporabi britanskih specifikacij za izvajanje BIM-pristopa in nakazuje, kako se lotevajo BIM-pristopa pri nas in pri vprašanju 14 o ovirah je dodan odgovor »Pomanjkanje nacionalnih smernic«.

Za raziskavo sem uporabil spletno anketo 1ka ter povabil k sodelovanju vse, ki delujejo na področju gradbeništva in jih zaprosil, če lahko delijo anketo naprej, zunaj svoje organizacije v kateri delujejo sami. Združenje siBIM pa je poslalo vabilo k sodelovanju tudi svojim članom, dodatno pa se je povabilo objavilo na Facebook strani podjetje Pilon, zastopnika za CAD program Graphisoft ArchiCAD.

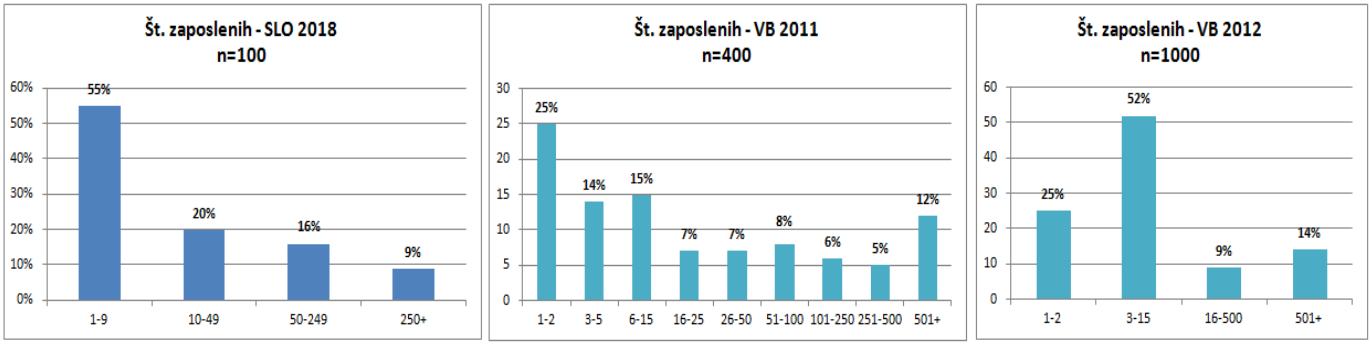
Na anketo se je odzvalo 296, od tega jih je na anketo kliknilo 128 anketirancev, ustreznih odgovorov za končno obdelavo rezultatov pa je bilo 100. Na prvo anketo NBS leta 2011 v VB je odgovorilo 400, v naslednjih letih pa okoli 1000 anketirancev.

V anketi je skupaj 47 vprašanj in trditev, ki so združena v 20 vprašanj, povprečen čas odgovarjanja na anketo pa je bil 7 minut in 6 sekund. Nekatera vprašanja sem segmentiral glede na tiste, ki BIM-pristop uporabljajo ali ga samo poznajo in ne uporabljajo, saj so nekatera vprašanja zastavljena tako, da nagovarjajo samo določen segment anketirancev. Tako so npr. iz samoocene uporabnikov BIM-pristopa izvzeti poznavalci (vpr.8), ki ločeno ovrednotijo lastno poznavanje BIM-pristopa v ločenem vprašanju (vpr.9). Bilo je tudi nekaj pisnih odzivov anketirancev, ki so preko spletne pošte podali svoje izkušnje in mnenja o BIM-pristopu, a ker niso sestavni del moje raziskave, jih ne bom vključil v poročilo. Vse ankete NBS, vprašalnik in podrobnejši rezultati moje raziskave se nahajajo v prilogi.

4.2 Rezultati raziskave

Uvodoma me je zanimalo število zaposlenih v njihovem podjetju, da bi dobil deleže, v kako velikih podjetjih anketiranci delujejo (Slika 13).

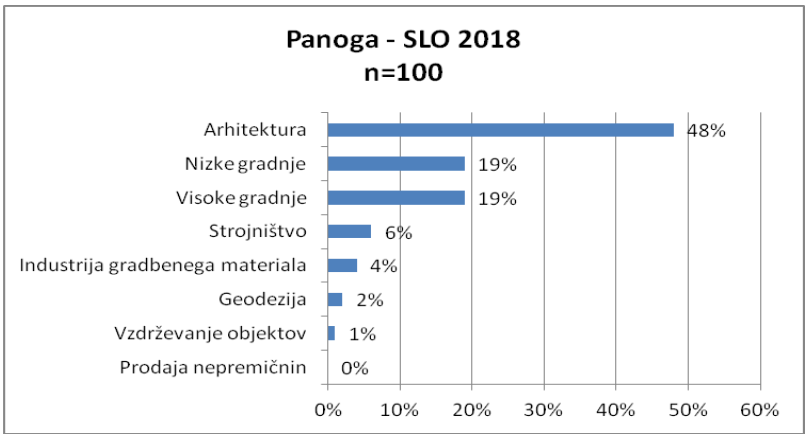
Slika 13: Razporeditev št. zaposlenih v anketah



Delitev velikosti slovenskih podjetij je povzeta po delitvi Statističnega urada RS. Več kot polovica anketirancev, tako angleške kot slovenske ankete, deluje v majhnih podjetjih, do 15 zaposlenih.

Sledilo je vprašanje, v kateri panogi anketiranec deluje (Slika 14).

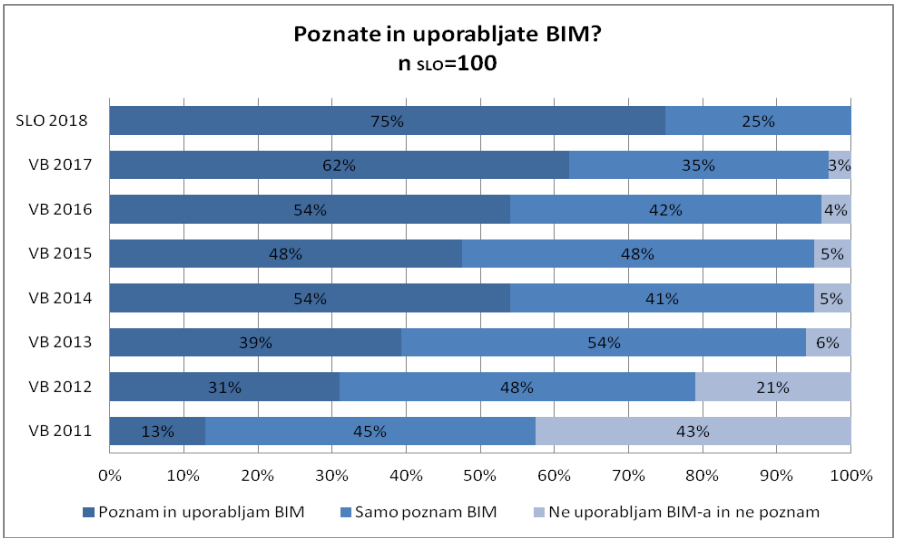
Slika 14: Zastopanost panog v slovenski anketi



Tudi v anketah NBS so arhitekti zasedali večinske deleže - leta 2012 48 %, leta 2013 44 % in leta 2016 51 %. V moji anketi je zaznan tudi vzdrževalec objektov, v podobnem deležu kot v NBS anketah, ni pa nobenega prodajalca nepremičnin, ki bi nakazoval na širjenje zunaj stroke. Zaradi obsega magistrskega dela so rezultati NBS anket dodani v prilogo.

Pri 3. vprašanju sem spraševal po uporabi in poznavanju BIM-pristopa (Slika 15).

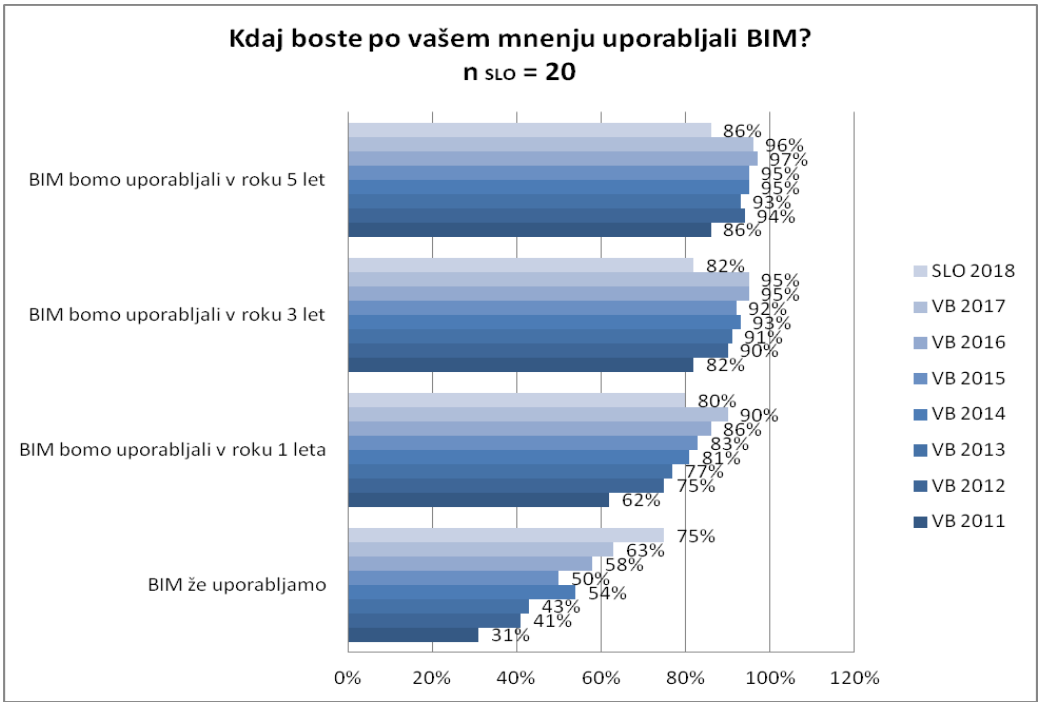
Slika 15: Deleži uporabnikov, poznavalcev in nepoznavalcev BIM-pristopa



V anketi je kar 75 % uporabnikov BIM-pristopa, kar je za 13 % točk več od ankete VB, ki je bila izvedena 1 leto po uvedbi obvezni uporabi za javna naročila, nepoznavalcev ni.

Na 4. vprašanje so poznavalci samoocenjevali morebitno prihodnjo uporabo BIM-pristopa (Slika 16).

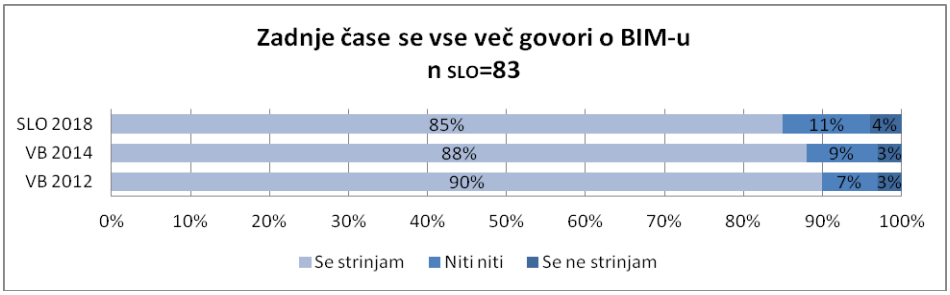
Slika 16: Pričakovani delež uporabe BIM-pristopa v prihodnosti



Na vprašanje je odgovorilo 20 poznavalcev, temu pa sem prištel še delež sedanjih uporabnikov BIM-pristopa (Slika 15). Če je delež slovenskih uporabnikov BIM-pristopa večji od VB, pa je pri slovenskih poznavalcih opaziti večji skepso o uveljavitvi BIM-pristopa v prihodnosti v primerjavi s poznavalci v VB.

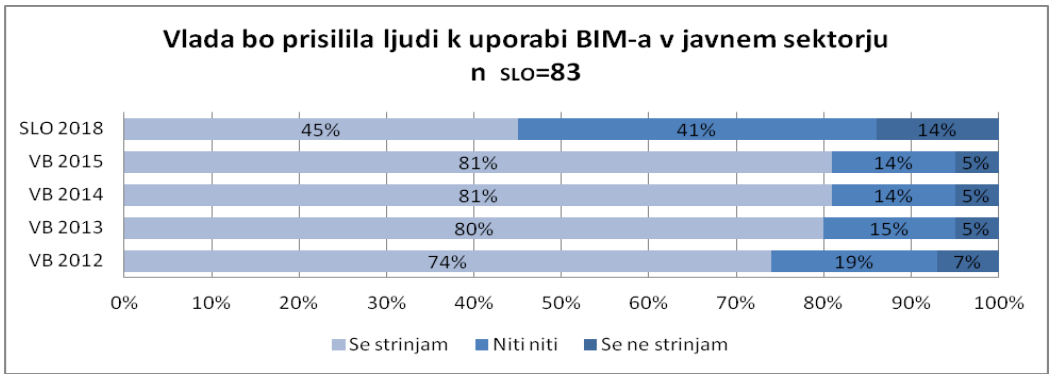
Sledi sklop vprašanj, ki poizvedujejo o uveljavljenosti in pričakovanjih anketirancev o BIM-pristopu (Slika 17 do Slike 25).

Slika 17: Primerjava aktualnosti teme o BIM-pristopu



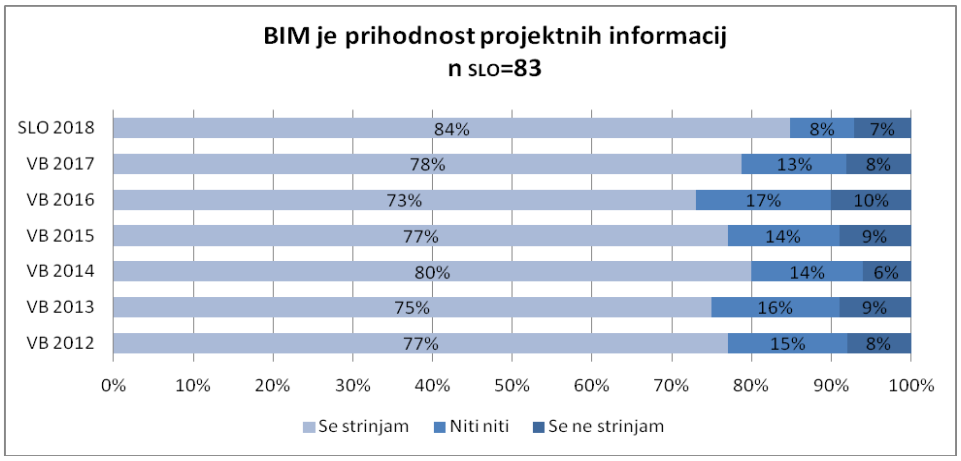
Raven v Sloveniji je zelo podobna z VB, kjer je celovit vladni program za uvedbo BIM-pristopa v javni sektor, torej uveljavitev od zgoraj navzdol, poleg tega pa imamo visok delež uporabnikov BIM-pristopa, kar nakazuje na pristop uveljavljanja od spodaj navzgor.

Slika 18: Pričakovanja do vlade pri vpeljavi BIM-pristopu



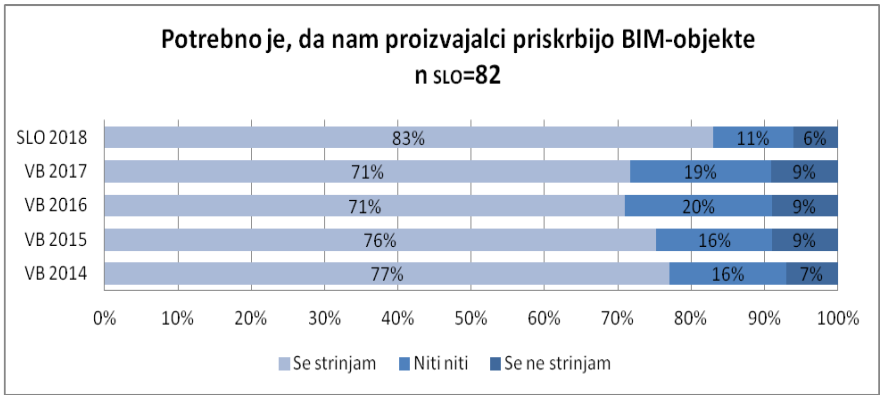
Kljub neobstoju vladnega programa uvajanja BIM-pristopa v primerjavi z VB, je 45 % delež visok in nakazuje obstoj trdnega prepričanja, da je BIM-pristop prihodnost izvajanja slovenskih javnih naročil ter se bo uveljavil tudi v javnem sektorju.

Slika 19: Mnenje o BIM-pristopu kot viru projektnih informacij



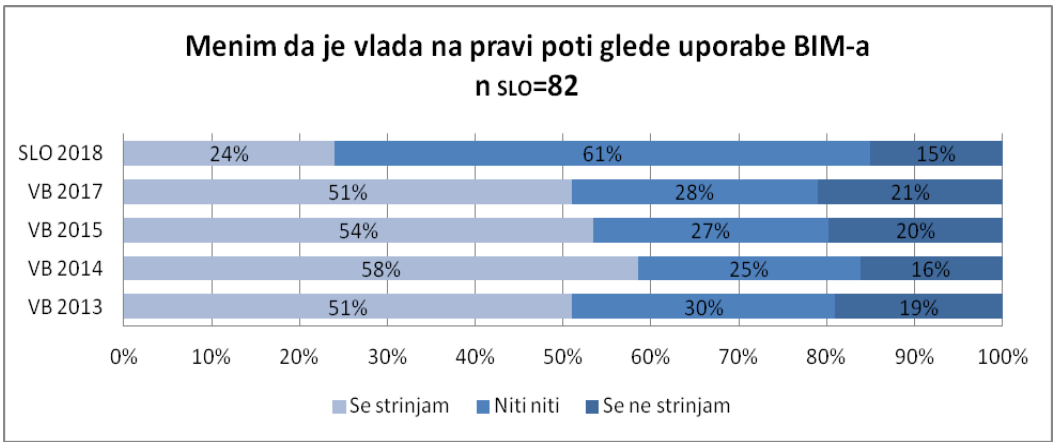
Ponovno imamo podobno razmerje kot VB, kar nakazuje splošno prepričanost, da je BIM-pristop potrebno nujno obravnavati danes, saj je to prihodnost izvajanja gradenj.

Slika 20: Proizvajalci in BIM-objekti



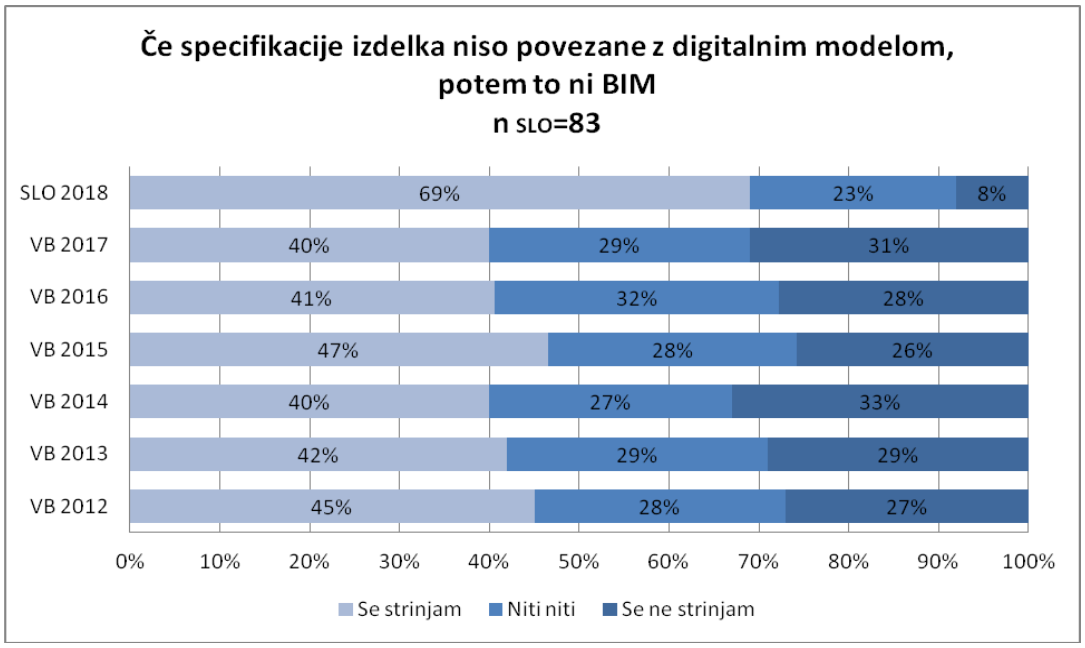
Slovenski ankentiranci so še v večjem deležu od VB mnenja, da so proizvajalci dolžni priskrbeti kakovostne BIM-objekte, zato pa bi bila potrebna difuzija BIM-pristopa v celotno verigo dobaviteljev, s tem pa se nakazuje bodoča potreba po BIM-modelarjih zunaj arhitekturnega in projektivnega okolja.

Slika 21: Mnenje o vladnih usmeritvah glede BIM-pristopa



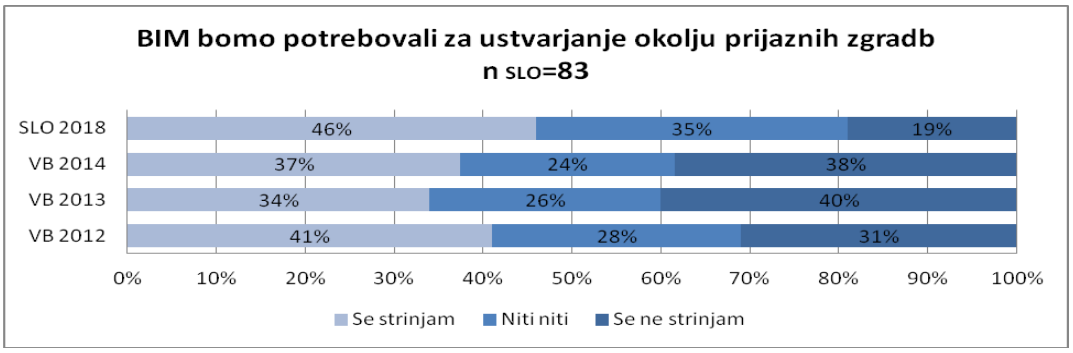
V VB je presenetljivo visok delež tistih, ki niso mnenja da je vlada na pravi poti glede BIM-pristopa. V Sloveniji ima 24 % odobravajoče mnenje, zato bi tu veljalo vprašati, zakaj so takega mnenja.

Slika 22: Mnenje o pomembnosti povezave specifikacij z BIM-modeli



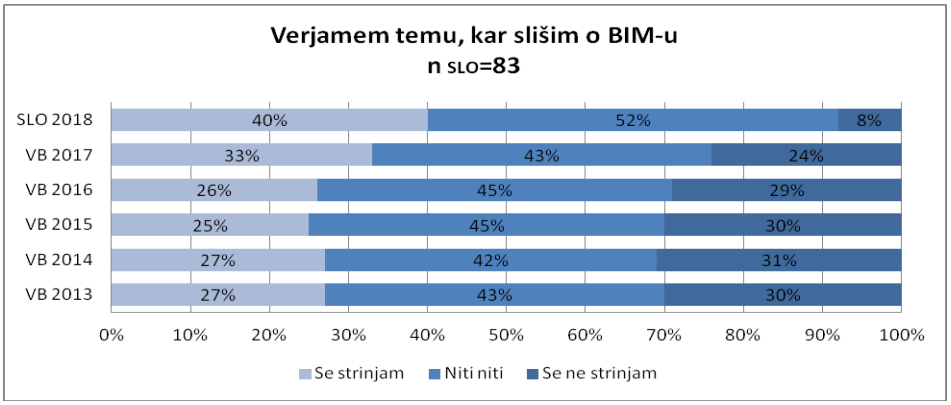
Odgovori jasno nakazujejo, da slovenski ankentiranci tesno povezujejo 3D CAD modele z združitvijo ostalih informacij o izdelku. Obstaja torej tako želja kot potreba za kakovostnimi BIM-modeli.

Slika 23: Mnenje o pomembnosti BIM-pristopa za okolju prijazno gradnjo



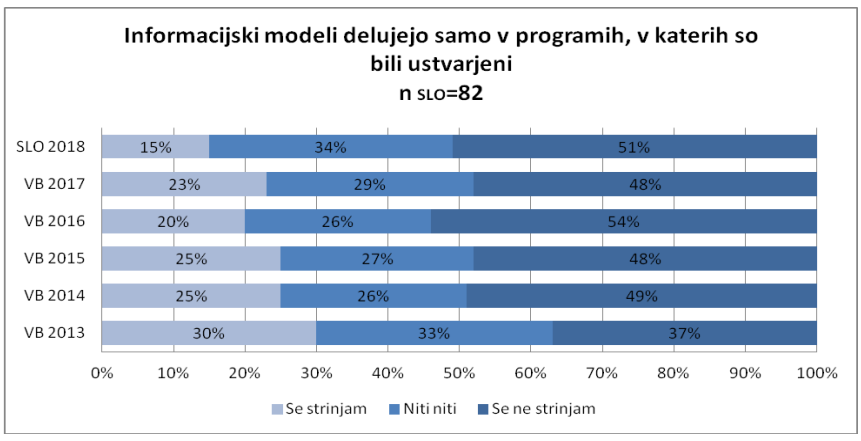
Slovenski ankentiranci v večji meri menijo, da je BIM-pristop pomemben za gradnjo okolju prijaznih zgradb, kar pripisujem predvsem boljšemu načrtovanju in optimiranju energetske porabe objektov.

Slika 24: Mnenje o kredibilnosti vira informacij



Slovenski anketiranci izkazujejo večje prepričanje o kredibilnosti in objektivnosti vira informacij o BIM-pristopu, v primerjavi z britanskimi. O virih informacij sprašujem v naslednjem, 6. vprašanju.

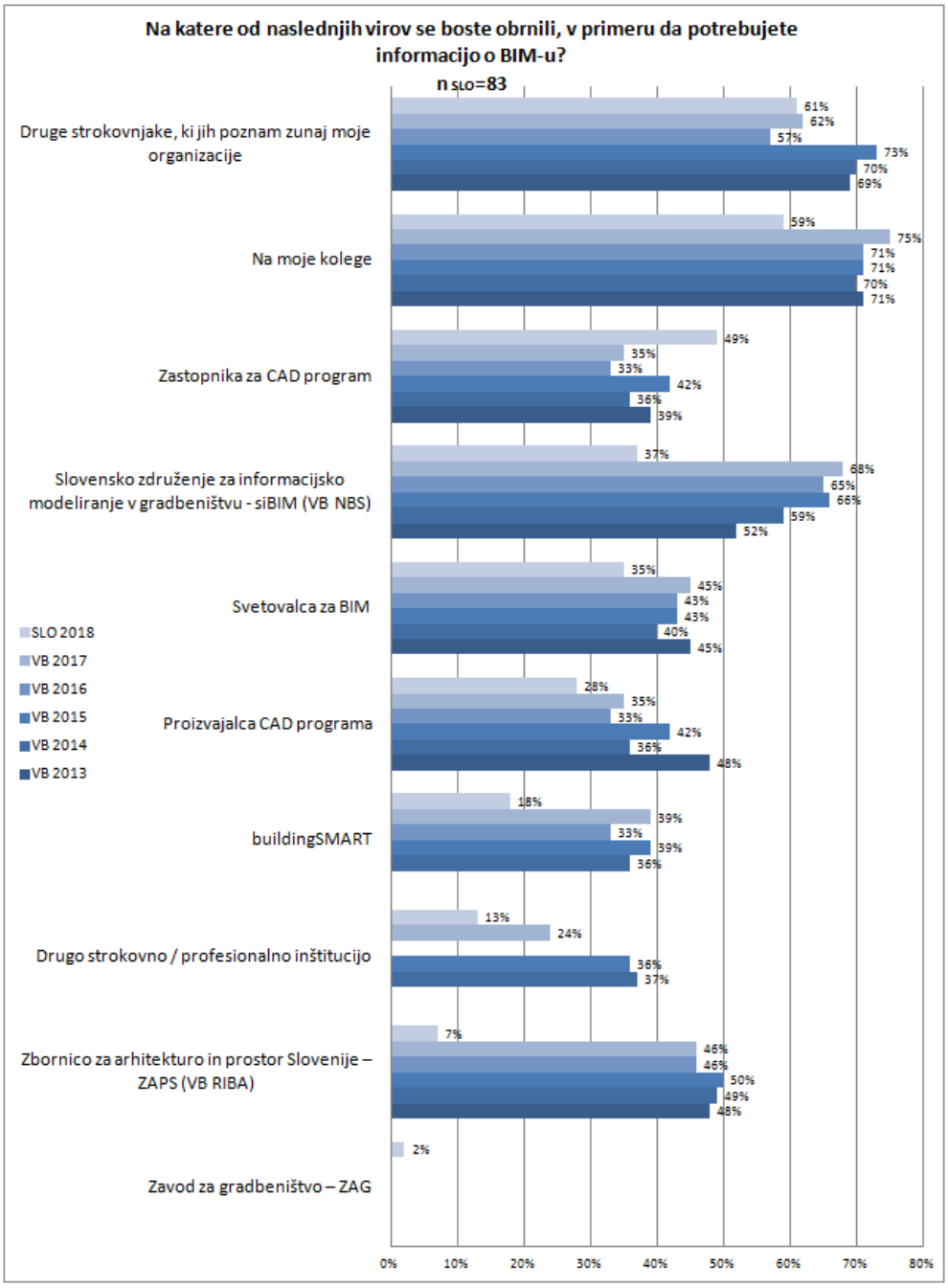
Slika 25: Izkušnje z interoperabilnostjo



Manjša odstopanja med britanskimi in slovenskimi anketiranci nakazuje, da si uporabniki delijo podobno izkušnjo z interoperabilnostjo BIM-pristopa. V VB se delež pozitivnih izkušenj skozi leta ni bistveno povečeval, zato je pri interoperabilnosti še prostor za napredek.

Želel sem izvedeti, kateri so glavni viri informacij o BIM-pristopu (Slika 26).

Slika 26: Viri informacij o BIM-pristopu

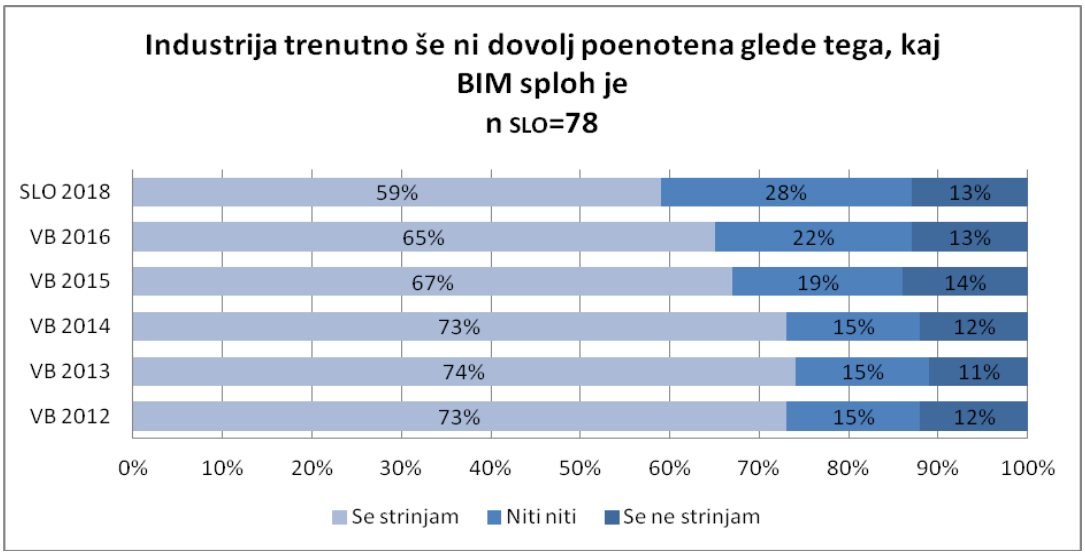


Viri informacij so v veliki meri podobni. Zagotovo je velik vpliv visokega kotiranja združenja siBIM na račun delitev ankete med njenimi člani, a je presenetljiva primerjava z

Zbornico za arhitekturo in prostor, ki se je glede na visok delež arhitektov v anketi, uvrstila na predzadnje mesto, s samo 7 %.

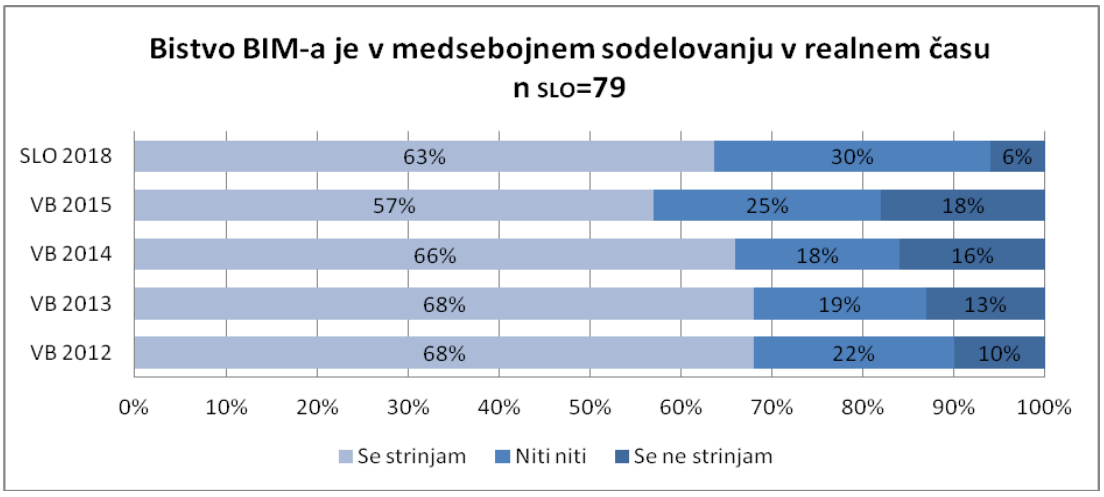
Sklop vprašanj je povpraševal po prevladujočih mnenjih uporabnikov in poznavalcev o BIM-pristopu (Slika 27 do Slika 33).

Slika 27: Mnenje o zrelosti BIM-pristopa



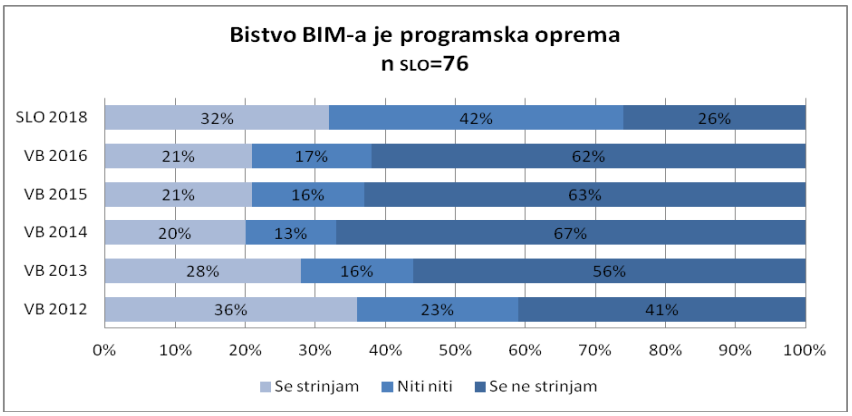
Deleži med Slovenijo in VB so si podobni, kar jasno nakazuje na podobne izkušnje in informacije med ankentiranci. BIM-pristop je torej še vedno v fazi razvoja in ni ustaljen pristop.

Slika 28: Mnenje o integrirani izvedbi projektov z BIM-pristopom



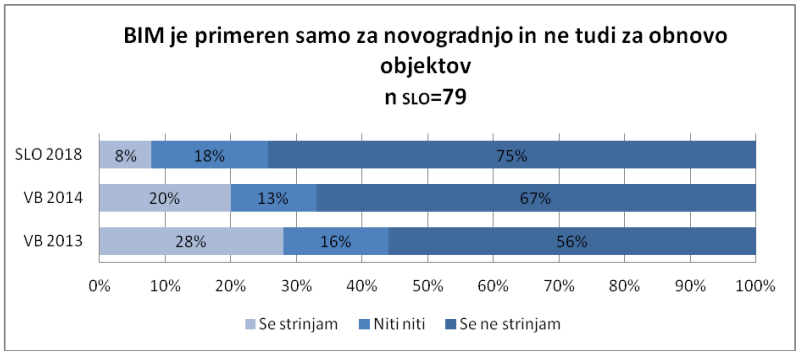
Majhen slovenski delež tistih, ki niso mnenja, da je medsebojno sodelovanje bistvo BIM-pristopa kaže, da je to med glavnimi lastnostmi BIM-pristopa, ki omogoča integrirano izvedbo gradbenih projektov z ostalimi deležniki.

Slika 29: Mnenje o bistvu BIM-pristopa



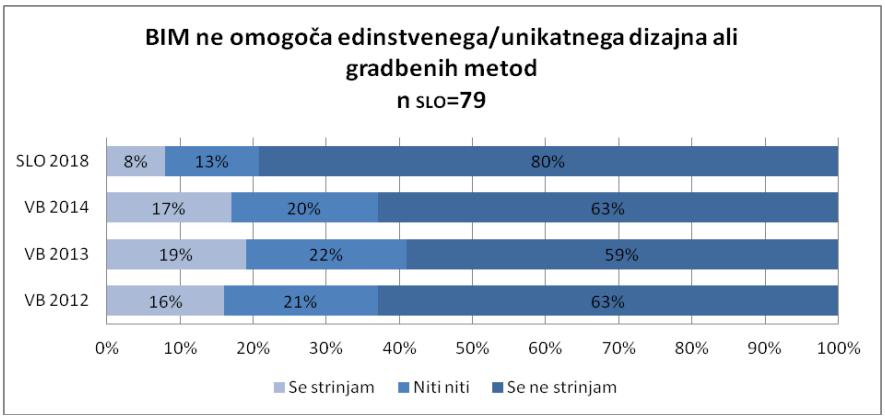
Slovenski delež tistih, ki so mnenja, da BIM-pristop ni samo programska oprema, kaže na razumevanje pomembnosti sinergije spleta tehnologije, procesov in ljudi. Prav tako opazimo bolj enakomerno razporeditev med deleži.

Slika 30: Izkušnje pri uporabi BIM-pristopa za obnovo gradenj



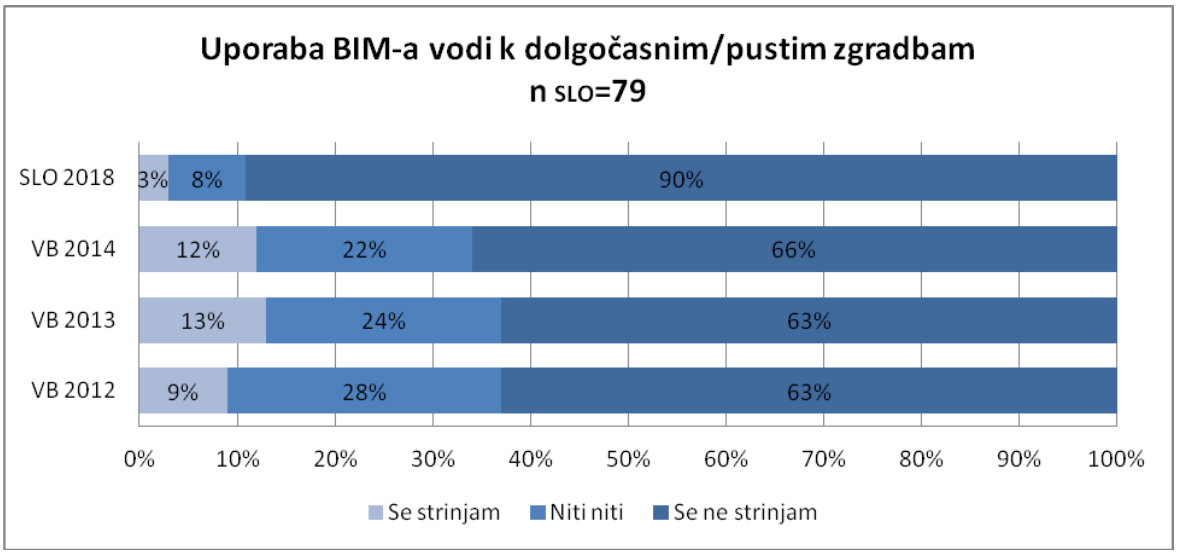
Slovenski ankentiranci so še bolj izrazitega mnenja, da je BIM-pristop uporaben za obnovo objektov. Recesija v gradbeništvu in majhno slovesnko tržišče narekujeta uporabo BIM-pristopa tudi v projektih obnove gradenj.

Slika 31: Izkušnje pri uporabi BIM-pristopa za izvedbo atipičnih gradenj



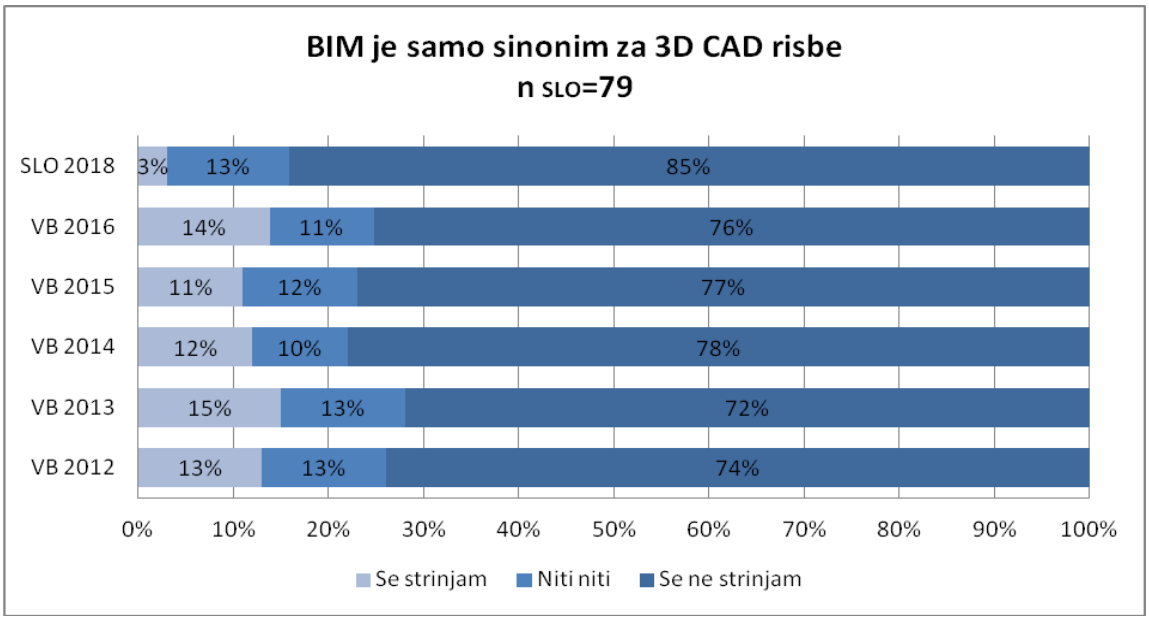
BIM-orodje naj bi bilo manj fleksibilno pri dizajniranju kot namenski 3D CAD program, a odgovori nakazujejo, da to ni omejitev za izvedbo arhitekturno zahtevnega projekta. Zaradi odsotnosti vprašanja v anketah NBS, ni možen vpogled ali se je mnenje bistveno spremenilo v obdobju po uvedbi.

Slika 32: Izkušnje pri uporabi BIM-pristopa za izvedbo arhitekturno zahtevnih gradenj



Podoben rezultat kot predhodno vprašanje potrjuje, da BIM-pristop ni ovira za izvedbo arhitekturno zahtevnih gradenj.

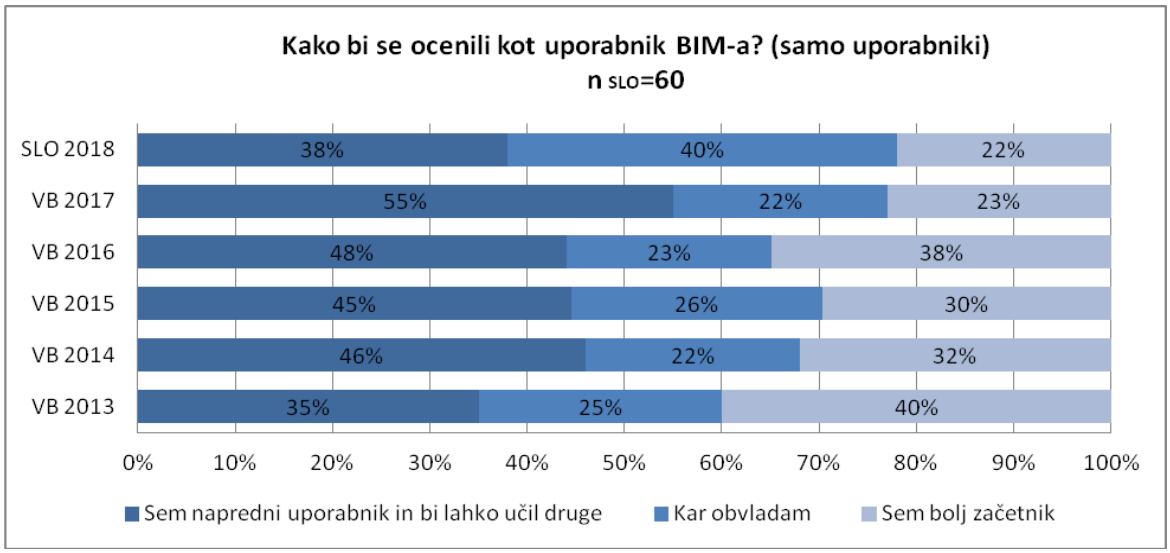
Slika 33: Razlikovanje BIM-pristopa in 3D CAD risb



Razlika izhaja najverjetneje iz deleža uporabnikov BIM-pristopa, ki je bila leta 2017 v VB 63 % (Slovenija 75 %) in posledično nepoznavanju BIM-pristopa.

Vprašanje 8 je bilo o samooceni uporabnikov BIM-pristopa (Slika 34).

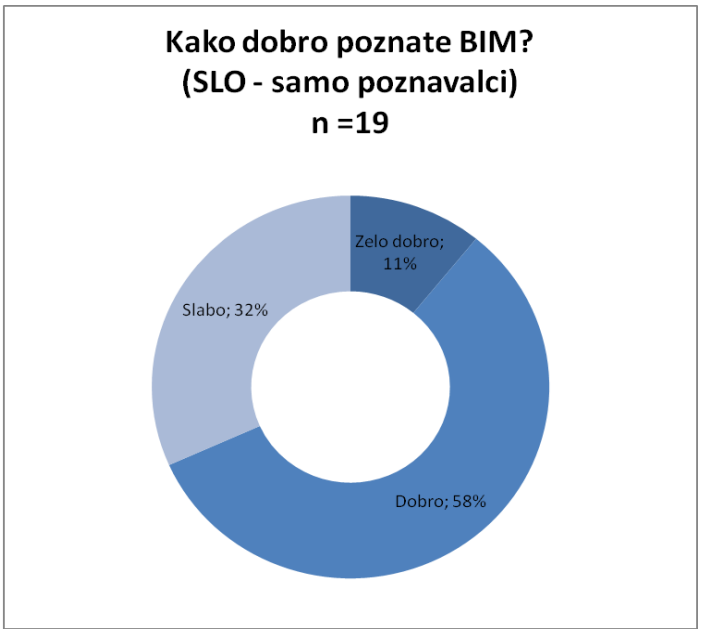
Slika 34: Samoocena uporabnikov BIM-pristopa



Zanimiva je razlika med naprednimi uporabniki in podobnim deležem tistih, ki se ocenjujejo kot začetniki. V navezi z vprašanjem 10, je to lahko znak pomanjkanja samozavesti.

Sledila je še samoocena poznavalcev BIM-pristopa v Sloveniji v vprašanju 10 (Slika 35).

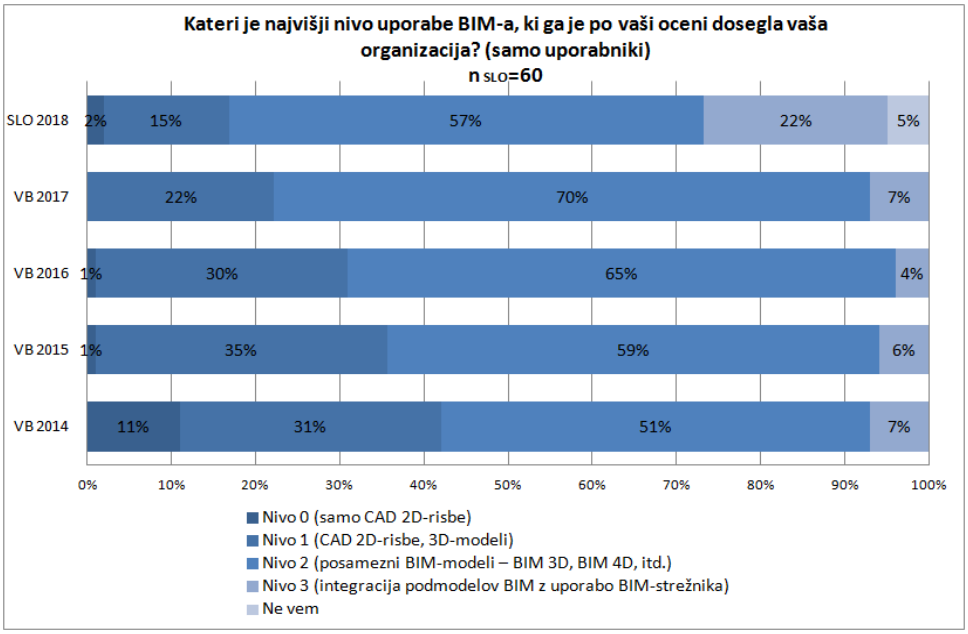
Slika 35: *Samoocena slovenskih poznavalcev BIM-pristopa*



Dvotretjinski delež poznavalcev meni, da je najmanj dobro seznanjena z BIM-pristopom, torej ima zbranih že nekaj informacij, ostaja tretjina pa je v fazi spoznavanja.

Uporabniki BIM-pristopa so v 11. vprašanju odgovorili o doseženih nivojih (Slika 36).

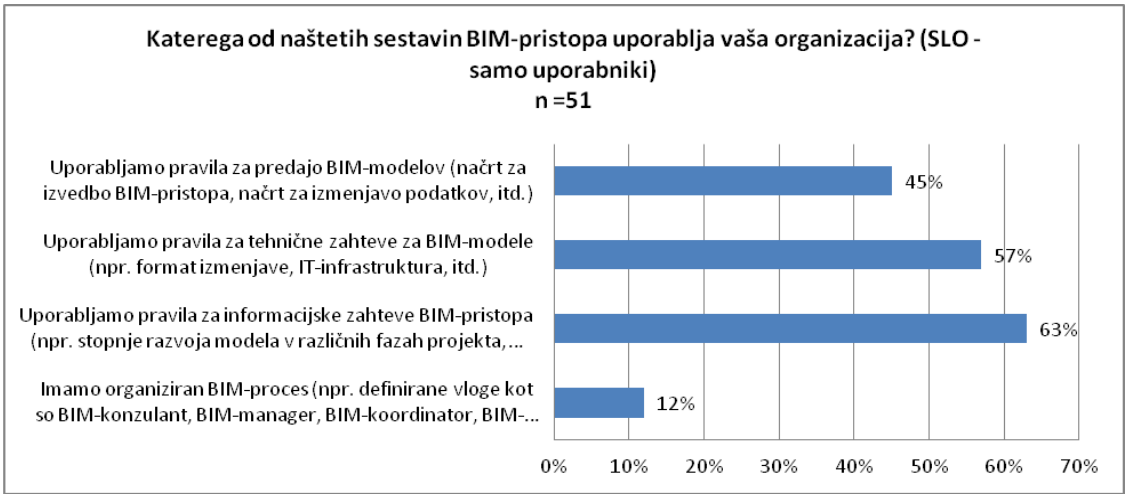
Slika 36: Deleži doseženih nivojev uporabnikov BIM-pristopa



Presenetljiv visok delež slovenskih uporabnikov je že dosegla BIM-nivo 3, kar nakazuje da obstaja dovolj močno poslovno okolje, ki tak pristop sploh omogoča. To potrjuje tudi zelo visok delež uporabe BIM-nivoja 2.

V 12. vprašanju sem spraševal o uporabi sestavin BIM-pristopa v slovenskih organizacijah.

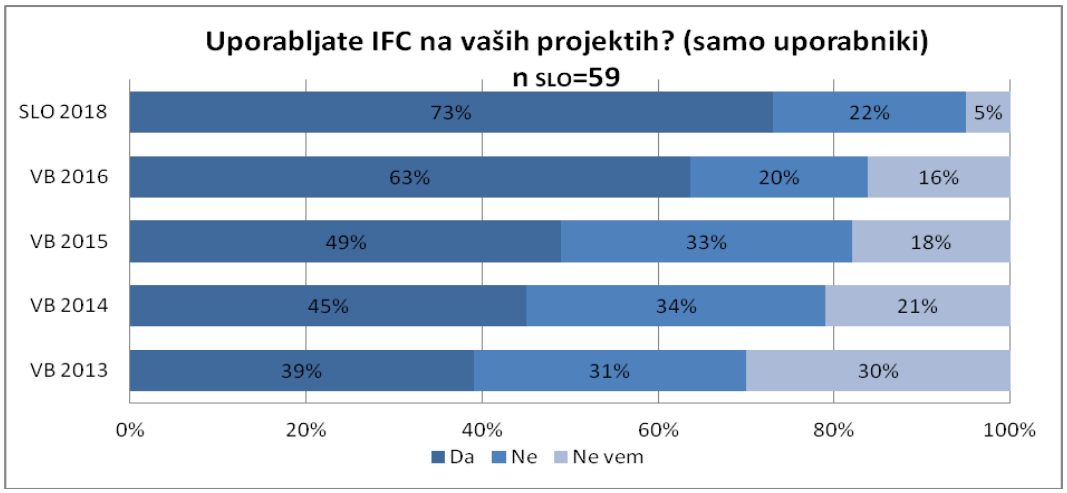
Slika 37: Uporaba sestavin BIM-pristopa v slovenskih organizacijah



Vprašanje je oblikovano glede na britanske specifikacije, ki pri nas niso v veljavi in jih zato ni možno primerjati. Znotraj slovenskih organizacij že obstajajo procesne delitve, razmejene s pravilniki, vloge pa še niso povsod jasno definirane.

Uporabniki so v 13. vprašanju vprašani o uporabi IFC formata (Slika 38).

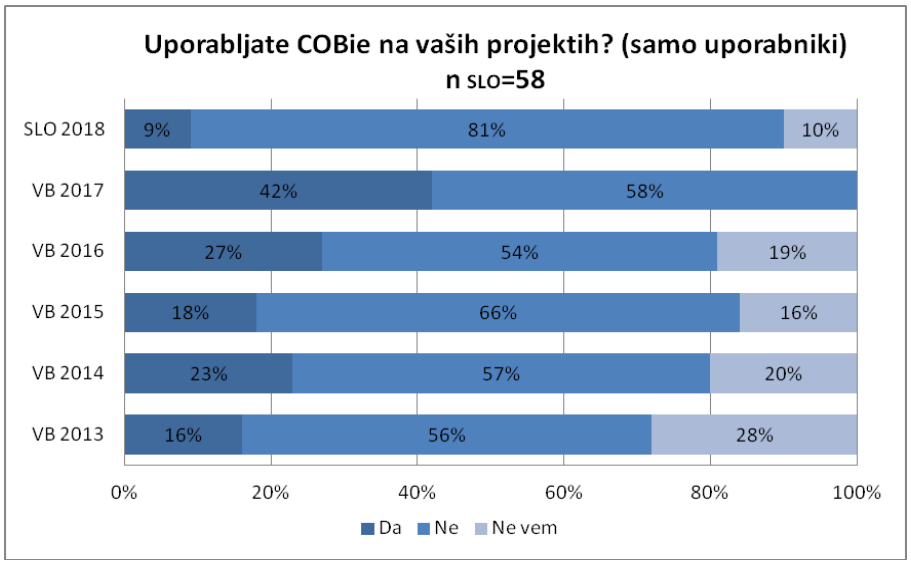
Slika 38: Poznavanje in uporaba IFC formata



Velik delež slovenskih uporabnikov, celo večji od britanskega, uporablja odprt IFC format, ki je temelj interoperabilnosti.

Nato so uporabniki bili vprašani še o uporaba COBie standarda (Slika 39).

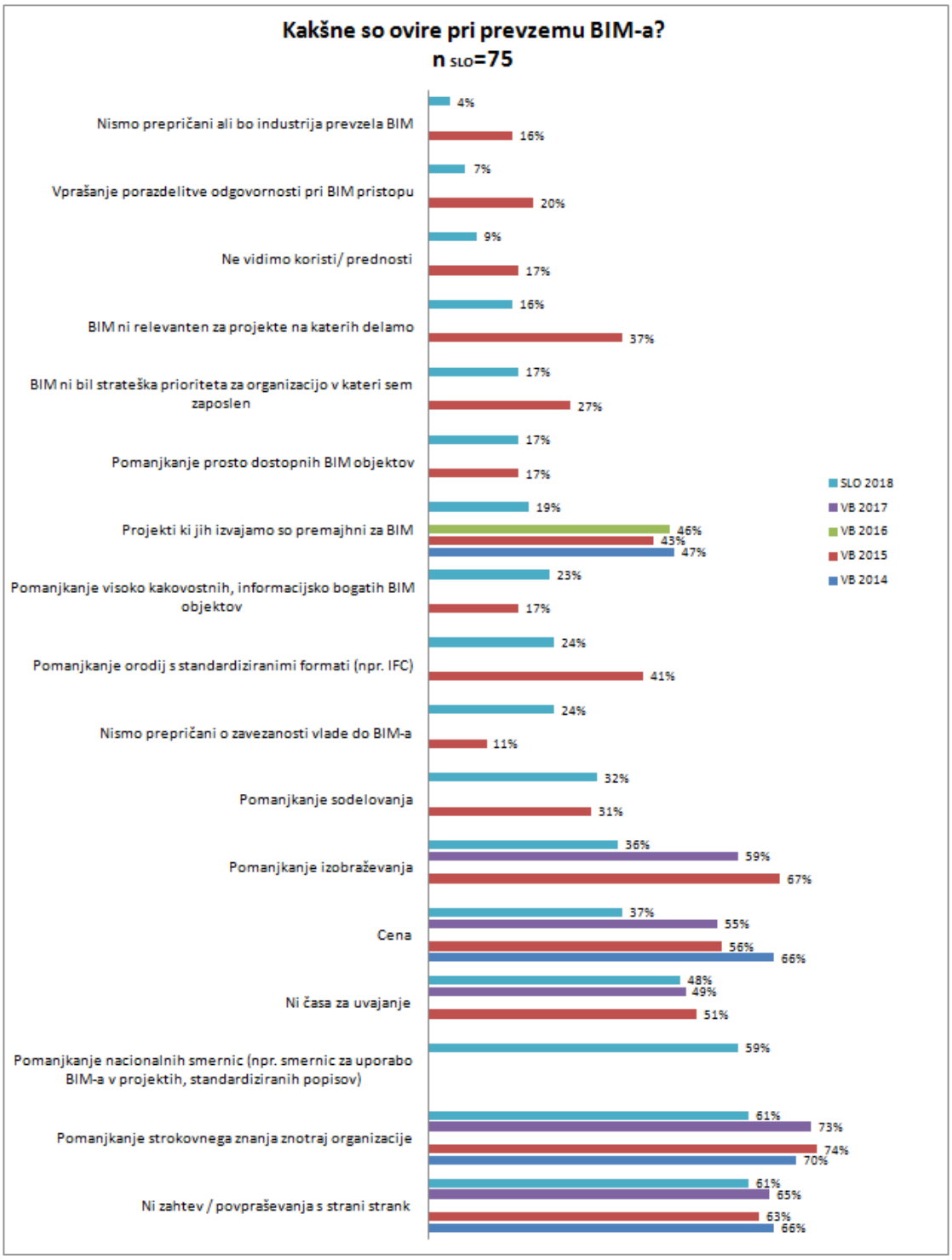
Slika 39: Poznavanje in uporaba COBie formata



Delež generiranja COBie formata je bistveno manjši v primerjavi z britanskimi anketiranci. Pri nastopu obvezne uporabe BIM-pristopa v VB, se je delež tistih, ki ustvarijo COBie format povečal za tretjino, nepoznavalcev pa bilo več ni zaznati.

Anketiranci so v bili 14. vprašanju vprašani o ovirah pri prevzemu BIM-pristopa (Slika 40).

Slika 40: Primerjava ovir pri prevzemu BIM-pristopa med Slovenijo in VB

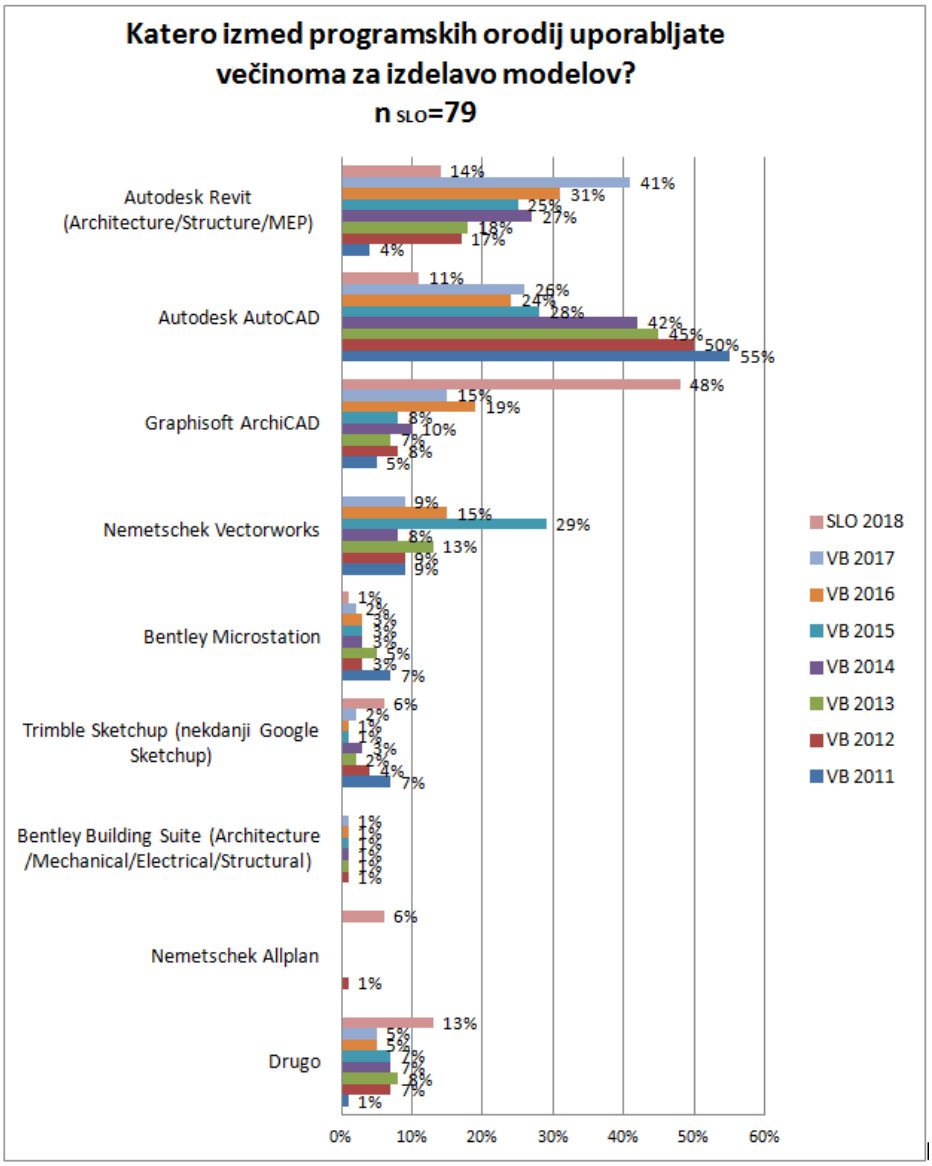


Porazdelitve ovir in deleži med VB ter SLO so si zelo podobni. Prve tri ključne ovire se delijo na zunanje in notranjo oviro. Povpraševanje strank je zunanja ovira, ki se tudi pri nas obravnava kot bistven motivator za širitev uporabe BIM-pristopa. Notranja ovira pa je občutek pomanjkanja strokovnega znanja znotraj organizacij, ki jih lahko na eni strani pripišem zahtevnosti vpeljave BIM-pristopa, saj potrebuje celovit pristop za učinkovito

uvedbo, na drugi strani pa je razlog občutek pomanjkanja nacionalnih smernic in standardov, ki bi dale uporabnikom jasen okvir, kako pristopiti k BIM-projektom, kot nakazuje 59 % delež odgovorov in jo uvrščam v zunanjo oviro. Prepričanje da bo industrija prevzela BIM-pristop je vsesplošen in je 4-krat nižji od deleža v VB leta 2015, 2 leti pred vpeljavo v javna naročila, kar je v nasprotju z rezultatom 4. vprašanja, kjer je bila izraženo slabše prepričanje o prihodnosti vpeljave BIM-pristopa v lastne organizacije anketirancev.

V 15. vprašanju me je zanimalo, katera programska orodja se najbolj uporablja (Slika 41).

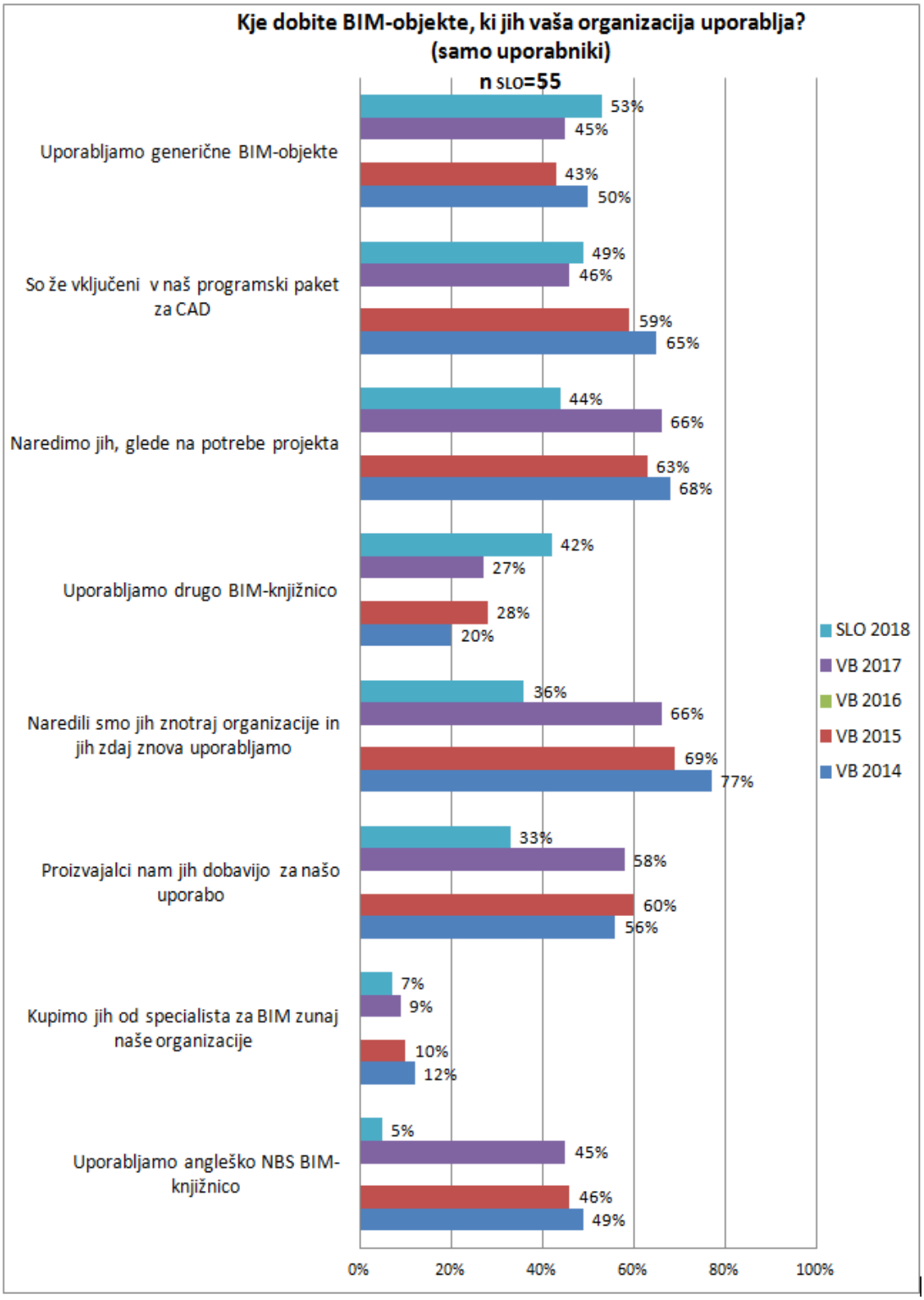
Slika 41: Uporaba programskih orodij



Tukaj se poraja vprašanje vpliva objave ankete na Facebook strani podjetja Pilon, ki je zastopnik programa Graphisfot Archicad, saj je ta v anketi najbolj uporabljen program s 48 %, v VB pa ima tretje mesto s 15 %. Programi AutoCAD-a so na 2. mestu s 25 %, v VB pa imajo 1. mesto s 67 % skupnim deležem.

Uporabniki so bili nato povprašani o virih BIM-objektov (Slika 42).

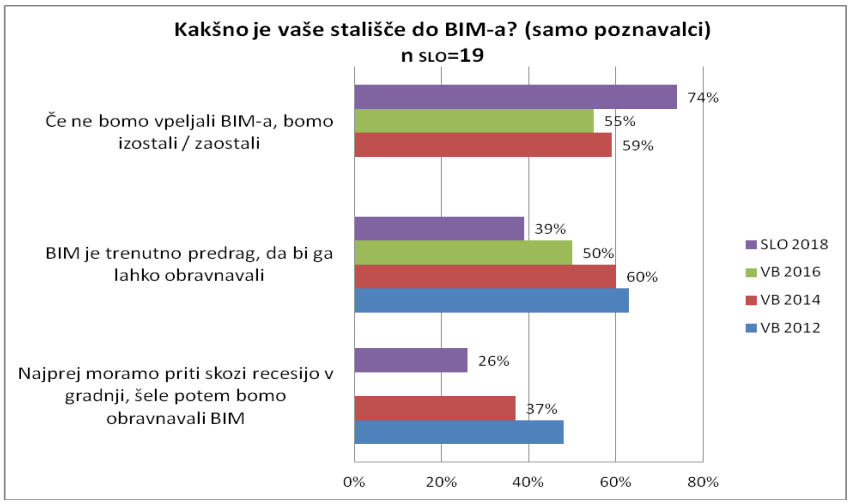
Slika 42: *Viri BIM-objektov*



Samo tretjinski delež slovenski uporabnikov dobi BIM-objekte od proizvajalcev, medtem ko je v VB ta delež 58 %. Na projektih pa se največ uporabi generične BIM-objekte ali pa so ti vključeni že v knjižnici CAD programa.

Prav tako so me zanimala stališča poznavalcev BIM-pristopa (Slika 43).

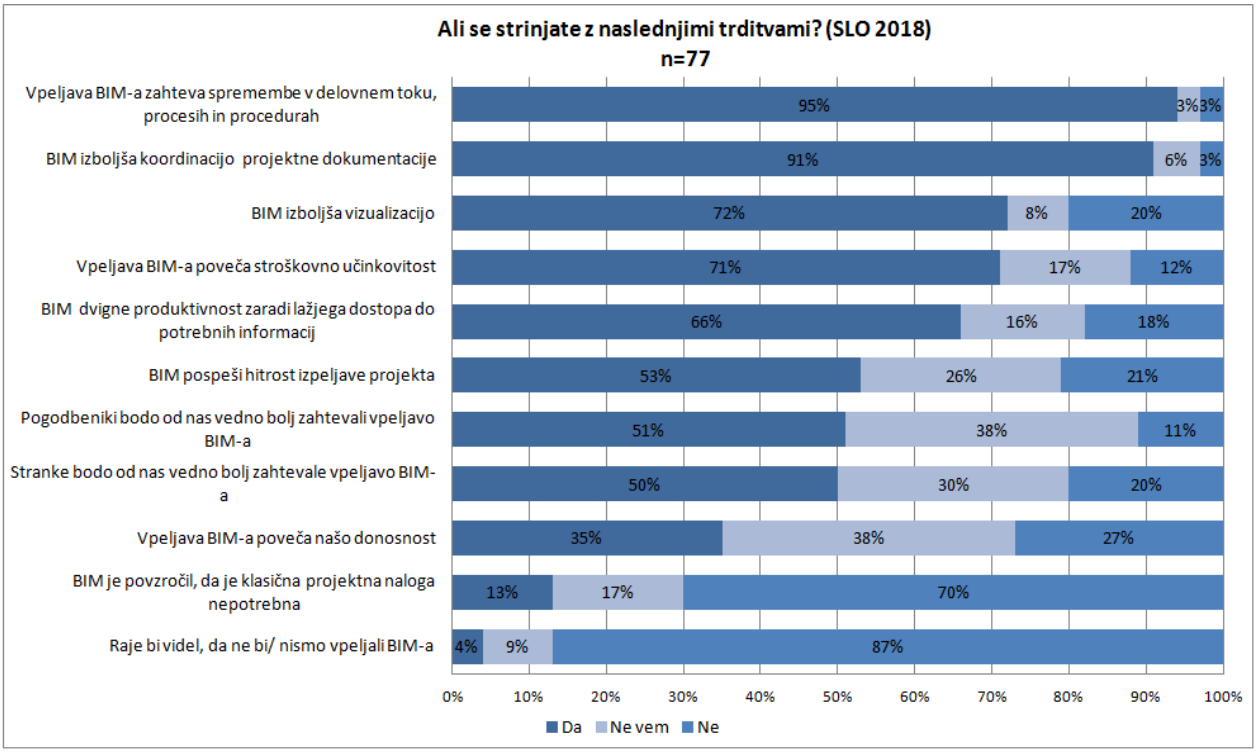
Slika 43: Stališča poznavalcev do BIM-pristopa



Odgovori nakazujejo, da je recesija v slovenskem gradbeništvu mimo, zato cena ni prevladujoča ovira pri odločitvi za BIM-pristop, temveč je strah pred nevpeljavo in posledično izgubo konkurenčnih prednosti.

O mnenjih o vpeljavi BIM-pristopa v slovenska podjetja sem spraševal v 18. vprašanju (Slika 44).

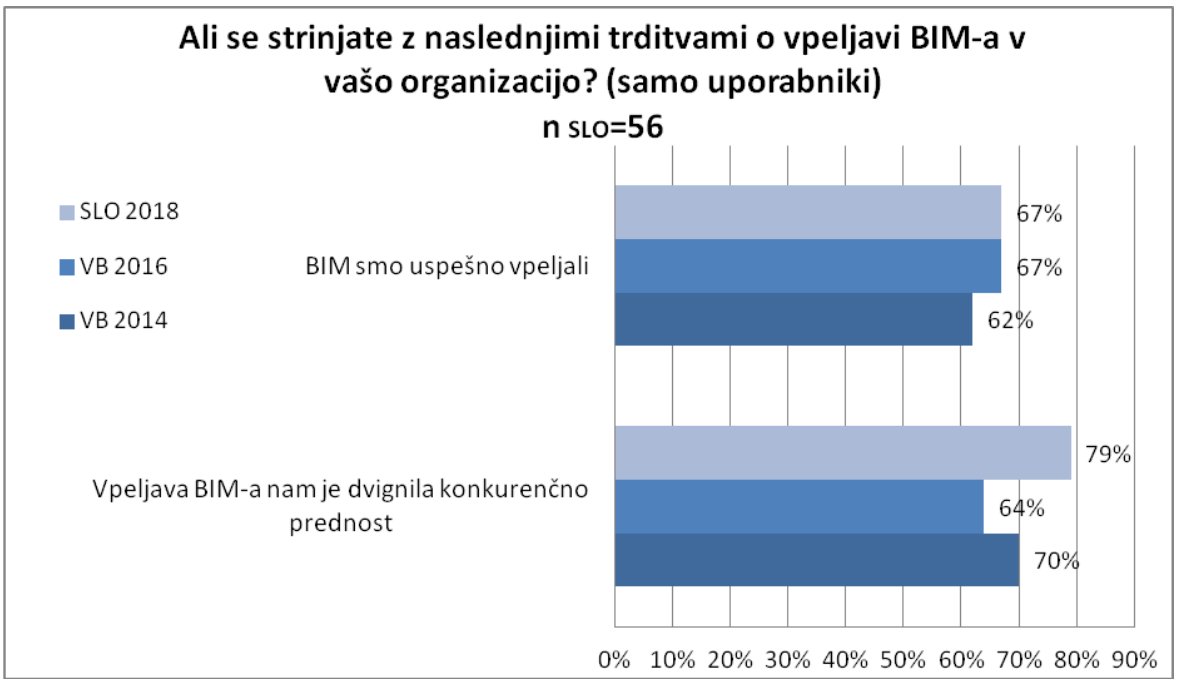
Slika 44: Mnenja o vpeljavi BIM-pristopa v slovenska podjetja



Zelo majhen odstotek je mnenja, da raje ne bi vpeljalo BIM-pristopa, čeprav ta ne odpravlja klasične projektne naloge. 71 % je mnenja o stroškovni učinkovitosti, 53 % pa je se strinja o pospešitvi izvedbe projekta, tudi zaradi bolje pripravljene projektne dokumentacije. Anketiranci v večini vedo, da BIM-pristop zahteva spremembe v delovnih procesih, ki pa izboljšajo vizualizacijo projekta in njeno projektno dokumentacije, zaradi boljše dostopnosti informacij pa se skozi večjo hitrost izvedbe posredno poveča tudi stroškovna učinkovitost. Anketiranci pričakujejo, da bodo vpeljavo BIM-pristopa zahtevale tako stranke kot pogodbeniki.

Slovenske uporabnike BIM-pristopa sem v 19. vprašanju povprašal o učinkih vpeljave (Slika 46).

Slika 45: Učinki vpeljave BIM-pristopa v slovenska podjetja

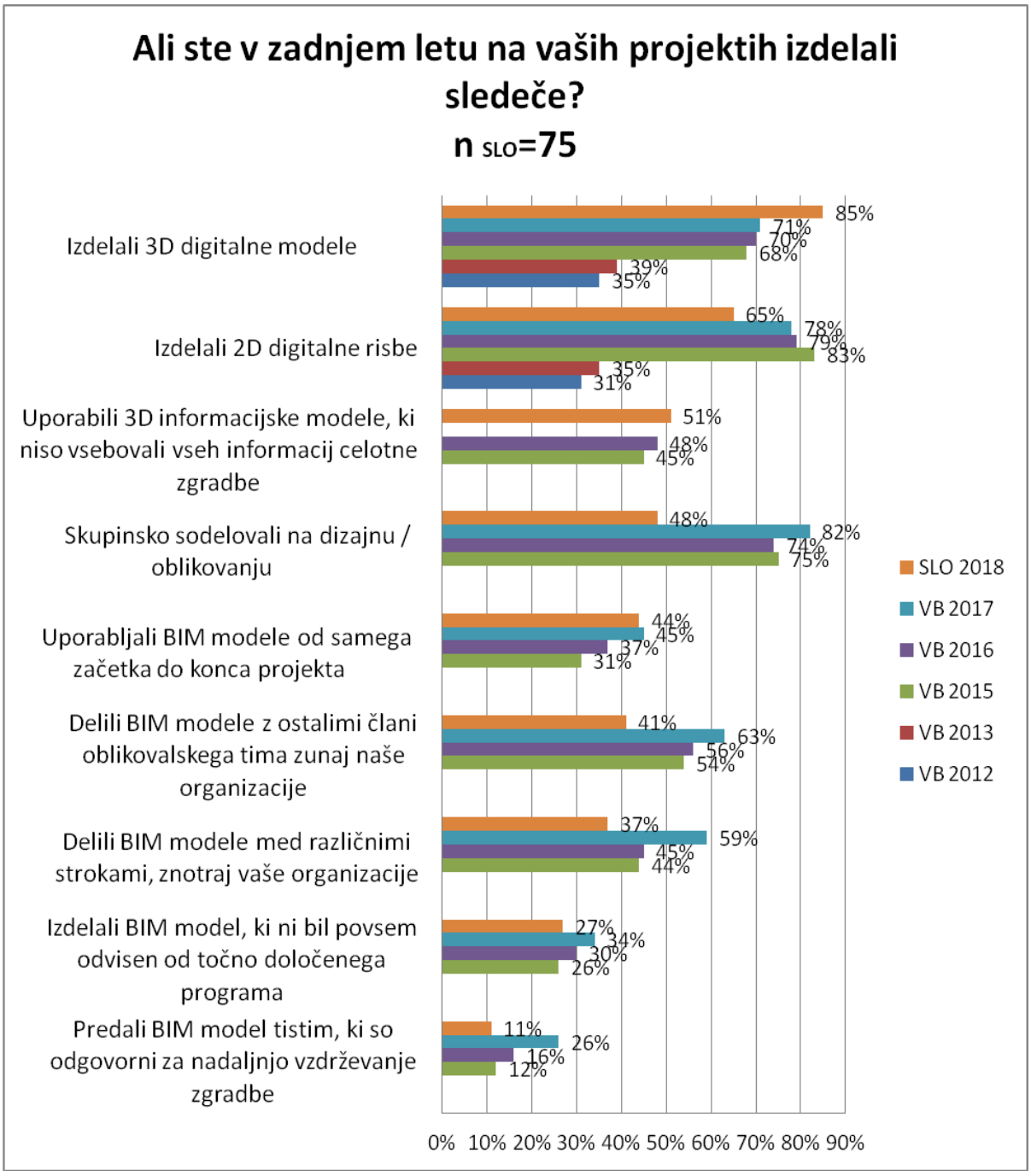


Deleži odgovorov o uspešni vpeljavi so enaki kot v VB, kjer so podjetja imela program za vpeljavo in podporo vlade. S tem se nakazuje, da v Sloveniji potekala implemenatcija BIM-pristopa od spodaj navzgor.

Še bolj pa je presenetljiva primerjava slovenskih in angleških uporabnikov BIM-pristopa, kjer je bistveno večji delež slovenskih uporabnikov mnenja, da jim je BIM-pristop dvignil konkurenčno prednost in s tem upravičili potrebne napore, vložene v njegovo vpeljavo. V primeru ponovitve ankete, bi bilo smotrno raziskati, zakaj imajo slovenski uporabniki BIM-pristopa v primerjavi z angleškimi toliko bolj pozitivne izkušnje.

Zadnje vprašanje je spraševalo o uporabljenih načinih izvedb projektov v zadnjem letu (Slika 46).

Slika 46: Uporabljeni načini izvedb projektov



Leta 2011 je v VB 34 % ročno risalo načrte, leta 2015 pa so se vsi digitilizirali. Izdelava 3D modelov je v veliki prednosti tako v primerjavi z VB kot z 2D digitalnimi risbami. Deljenje BIM-modelov tako znotraj kot zunaj organizacije je v primerjavi z VB manjše, pravtako je manj skupinskega sodelovanja na dizajnu/oblikovanju. Manjši je tudi slovenski delež pri predaji BIM-modelov naročniku, a je ta v VB narastel po vpeljavi BIM-pristopa v javna naročila.

4.3 Odgovori na raziskovalna vprašanja

V uvodnem delu sem zapisal, da sem si zastavil 3 raziskovalna vprašanja, na katere naj bi odgovorila anketna raziskava in sicer:

1. v kakšni meri zaostaja uporaba BIM-pristopa v Sloveniji za VB,
2. katere so ključne podobnosti in razlike v delovanju slovenskih ter britanskih podjetij,
3. katere ukrepe in spremembe bi slovenska podjetja morala uvesti, če bi želela stopiti na pot BIM-pristopa.

Najbolj presenetljiv rezultat, ki obenem odgovarja tudi na moje 1. raziskovalno vprašanje, je dalo 3. anketno vprašanje o poznavanju in uporabi BIM-pristopa, saj je 75 % delež uporabnikov v Sloveniji celo višji, kot je bil v VB leta 2017, po uvedbi obvezne uporabe BIM-pristopa v izvedbi vseh javnih gradbenih naročil, nepoznavalcev pa sploh ni. Temu dejstvu lahko pripišem dva razloga – eden je majhnost slovenskega trga v primerjavi z ameriškim in britanskim, drugi pa je močan vpliv povabila k sodelovanju članov združenja siBIM kot tudi sledilcev Facebook strani podjetja Pilon, ki je zastopnik popularnega BIM-programskega orodja ArchiCAD. BIM-pristop je v slovenskih podjetjih že dobro uveljavljen, saj se uporablja tako za načrtovanje novih gradenj, kot tudi obnovo, odgovori pa nakazujejo da uporabniki zelo dobro poznajo prednosti in slabosti BIM-pristopa. Slovenija zaostaja predvsem pri vpeljevanju BIM-pristopa v državne organe in zakonodajo. Če je stopnja ozaveščenosti in uporaba BIM-pristopa visoka, pa je splošno prepričanje slovenskih poznavalcev bolj skeptično od poznavalcev VB in v prihodnosti pričakujejo manjšo stopnjo implementacije BIM-pristopa v slovensko gradbeništvo, kljub temu da je po njihovem trdnem prepričanju BIM-pristop prihodnost projektnih informacij. Z nizko stopnjo samozavesti se ponovno srečamo pri samooceni uporabnikov BIM-pristopa, ki so se ocenili slabše od britanskih uporabnikov in to kljub dejstvu, da izvajajo projektne naloge na BIM-stopnji 3 v bistveno večjem deležu od britanskih anketirancev ter da je primerljiv delež uporabnikov, ki so mnenja, da so BIM-pristop uspešno vpeljali. Struktura vira informacij o BIM-pristopu kot tudi večinsko prepričanje, da se o BIM-pristopu vedno več govori, nakazuje, da se ljudje vedno bolj srečujejo s to tematiko in se sami odločajo za iskanje virov informacij. Kljub pomanjkanju javnih smernic za vpeljavo, je delež podjetij s vpeljanim BIM-pristopom v primerljivem deležu z VB (slovenskih 79 % z britanskimi 77 %), po uvedbi BIM-pristopa v njihova javna naročila. A je zato slovenski 22 % delež doseženega BIM-stopnje 3 bistveno večji od britanskih 7 %. Za doseganje BIM-stopnje 3 pa je potrebno imeti poleg dovolj razvitega celovitega poslovnega okolja tudi IKT strukturo, ki torej v Sloveniji že obstaja, da je tako visoka BIM-stopnja sploh lahko dosegljiva. Razširjenost uporabe BIM-stopenj 2 in 3 je možno zaznati v anketi tudi preko drugih rezultatov, saj imamo široko uporabo odprtega IFC formata, ki je nujen za doseganje interoperabilnosti, razširjeno zavest, da BIM-pristop na prvem mestu zahteva spremembo v delovnih tokovih, pomanjkanje in posledično tudi široko potrebo po kakovostnih, informacijsko bogatih BIM-objektih proizvajalcev ter nenazadnje imajo pri

uporabi BIM-pristopa slovenski anketiranci podobne izkušnje kot britanski. BIM-pristop je torej v slovenskih podjetjih vsaj tako dobro uveljavljen, kot v angleških, zaostajamo pa predvsem pri implementaciji v slovenska javna naročila in zakonodajo.

Na 2. raziskovalno vprašanje lahko odgovorim, da je ključna razlika majhnost slovenskega tržišča v primerjavi z angleškim, ključna podobnost pa je delež majhnih podjetij, ki deluje v gradbeni panogi. Eden izmed glavnih argumentov vpeljave BIM-pristopa v javna naročila VB je povečanje konkurenčnosti, zaradi možnosti participacije tudi manjših podjetij ter posledično bolj enakomerne porazdelitve dobičkov med velikimi in majhnimi podjetji. BIM-pristop naj bi bilo odprto delovno okolje, v katero lahko vstopijo tudi manjša podjetja, ki nimajo močnih finančnih zaledij in si ne morejo privoščiti dolgotrajnih vpeljevanj. To se je pokazalo tudi pri ovirah, saj je cena obravnavana kot veliko manjša ovira v primerjavi s pomanjkanjem časa za šolanje in znanje, ki ga imajo. Ker pa je slovensko tržišče majhno, delež majhnih podjetij pa velik, so tako kot skandinavska podjetja primorana k uporabi BIM–pristopa tudi na projektih obnov in izvedbe unikatnih arhitekturnih dizajnov, pri tem pa imajo bistveno bolj pozitivne izkušnje kot britanska podjetja. Pri uporabi BIM-pristopa je raziskava pokazala, da slovenski anketiranci zaznavajo predvsem izboljšano koordinacijo projektne dokumentacije, s katero organizacije dosegajo manjše število napak in izboljšajo stroškovno učinkovitost (71 %), povečajo produktivnost (66 %) in hitrost izvedbe (53 %), medtem ko nimajo tako zelo povečane donosnosti (35 %). BIM-pristop torej vpliva tako na planiranje stroškov kot tudi časa, ki sta še toliko pomembnejša za majhna podjetja. Hkrati pa se potrjuje teorija, da naročnik projekta z zahtevo po uporabi BIM-pristopa pridobi za svoj denar več dodane vrednosti, saj izvajalci generirajo večji dobiček z zmanjševanjem stroškov na račun hitrosti in manjšega števila napak. Za uspešno implementacijo BIM-pristopa je pravtako pomembno sodelovanje med deležniki tako v vertikalni kot horizontalni verigi, saj je s tem omogočen boljši in kakovostnejši pretok informacij in posledično lajšanje opravljanja zahtevanih nalog ter zmanjševanje tveganj pri izvedbi projekta. Majhnost trga narekuje večkratno sodelovanje med deležniki gradbenih projektov, zato se je skozi skupne izkušnje omogočilo vzpostavljanje rednih in ustaljenih odnosov, ki krepijo občutek zaupanja in s tem tudi bolj odprto komunikacijo ter posledično lažje izvajanje projektov. Če povzamem, je torej odgovor na 2. raziskovalno vprašanje, da je ključna podobnost velikost podjetij in prednosti, ki jih uporabniki z uporabo BIM-pristopa dobijo, medtem ko je ključna razlika majhnost trga in odsotnost državnega programa za uvajanje obvezne uporabe BIM-pristopa v javnih naročilih in zakonodaji.

Zaradi visokih deležev uporabe BIM-stopenj 2 in 3, kot tudi drugih rezultatov anketnega vprašalnika, ki nakazujejo na visoko stopnjo poznavanja in izkušenost uporabnikov, sem dobil odgovor tudi na 3. raziskovalno vprašanje, zato bi s težavo predlagal katere ukrepe naj podjetja sprejmejo pri vpeljevanju BIM-pristopa. Veljalo bi predvsem usmeriti pozornost na državo Slovenijo, ali ta sledi in se primerno odziva na trenutno stanje pri nas in tudi v svetu. Če 45% delež uporabnikov pričakuje vpeljavo BIM-pristopa v zakonodajo,

pa jih je samo 14% mnenja, da temu ne bo tako, kar nakazuje na obstoj pričakovanja, da bo Slovenija sledila ostalim državam, ki so BIM-pristop že vpeljale v sistem javnega naročanja, tako kot je to storila tudi VB. Kot glavna razloga za obravnavanje in vpeljevanje BIM-pristopa pri poznavalcih sta predvsem strah pred izgubo konkurenčnih prednosti in pričakovanje povečanja zahtev s strani naročnikov in to navkljub pomanjkanju povpraševanja s strani naročnikov, kar je v anketah prepoznana kot glavna ovira pri implementaciji tako v Sloveniji, kot tudi v ZDA in VB. Tako kot je to prepoznala in storila VB, bi morala enako storiti tudi Slovenija, saj je država obenem glavni naročnik in tudi zakonodajno telo, ki ima dovolj vpliva, da odstrani glavne ovire pri implementaciji BIM-pristopa z aktivnim programom uvajanja BIM-pristopa v javna gradbena naročila. Rezultati ankete to potrjujejo, saj slovenski anketiranci postavljajo na 2. mesto ovir (59 %) pomanjkanje javnih smernic za uporabo BIM-pristopa in standardiziranih predpisov takoj za pomanjkanjem zahtev s strani naročnika (to je države) in strokovnega znanja znotraj organizacije (oba 61 %). Odsotnost jasnega javnega programa uvedbe BIM-pristopa kažeta tudi rezultata, da dve tretjini anketirancev nima mnenja o tem, ali je slovenska vlada na pravi poti glede uporabe BIM-pristopa, prav tako pa je v Sloveniji izredno majhen delež uporabe COBie formata v primerjavi z VB, ki je po uvedbi BIM-pristopa podvojila njegovo generiranje in s tem pričela graditi na bazi podatkov, ki bo potrebna za izvedbo naprednih projektov, kot so inteligentna, ekološka in adaptivna grajena okolja, ki jim bodo pomagala se soočati z izzivi, ki jih prinašajo demografske in ekonomske spremembe v prihodnosti. Slovenske javne smernice bi morale spodbujati generiranje COBie formatov, če se želi zgraditi zdrav lasten temelj, potreben za izvajanje prihodnjih naprednih gradenj. Pravtako je anketa pa pokazala jasno razliko pri virih informacij v primerjavi med slovenskim in britanskim vzorcem, saj slovenske javne organizacije niso deležne tako velikega zaupanja kot kredibilen vir informacij. Tako je ZAPS kljub visokemu deležu arhitektov na predzadnjem mestu virov informacij. Vse to se lahko pripisuje dejstvu, da pri nas nimamo vpeljanega javnega programa za uvajanje BIM-pristopa v javna naročila.

Na koncu moram izpostaviti še nekaj omejitev svoje raziskave. Zaradi omejitev magistrskega dela pa tudi obsežnosti raziskave, ni bilo možno zajeti vseh vprašanj o različnih aspektih vpeljave in uporabe BIM-pristopa, zato bi ob morebitni ponovitvi anketne raziskave veljalo razmisliti tudi o spremembi vprašalnika, tako kot je to izvajala angleški NBS. V britanskem vprašalniku se na primer primerjajo odgovori na 18. vprašanje med uporabniki in poznavalci BIM-pristopa, zato bi ob morebitni ponovitvi ankete veljalo izvesti enako primerjavo mnenj tudi med slovenskimi in angleškimi ankentiranci. Pravtako bi bilo smotrno vprašalnik še bolj prirediti za slovensko tržno raziskavo in poiskati še bolj podrobne odogovore na posamezna vprašanja, kot je na primer odkriti vzrok, zakaj so slovenski uporabniki BIM-pristopa bolj pozitivnega mnenja, da jim je vpeljava dvignila konkurenčno prednost, kot so tega mnenja angleški uporabniki in to kljub odsotnosti vladnega programa za obvezno vpeljavo v javna naročila ter enakemu prepoznavanju ovir za vpeljavo BIM-pristopa, kot je na primer odsotnost povpraševanja s strani naročnikov.

SKLEP

Z namenom seznanjanja in spodbujanja uporabe informacijskega modeliranja v Sloveniji, pomagati potencialnim uporabnikom pri odločitvi za uporabo informacijskega modeliranja, ter spodbujanja razmisleka o zakonski obveznosti vpeljave BIM-pristopa v javna naročila po vzoru VB, sem si za cilj zastavil primerjavo stanja BIM-pristopa v Sloveniji z VB, kjer naj bi bil najbolj uveljavljen, in sicer z izvedbo empirične raziskave, to je ankete ter kritičnim pregledom strokovne literature.

Ker so po definiciji PMBOK-a gradbeni projekti definirani kot začasna prizadevanja za uresničitev edinstvenega izdelka, imajo aktivnosti določen začetek in konec, ki so odvisne od zadanega časovnega okvirja. Edinstvenost projekta pa zahteva, da projekte pred vsako izvedbo vsakič znova definiramo, zato da bi jih kasneje tudi uspešno realizirali. Projekti so deljeni na 4 faze, ki jih lahko delimo na dva dela: faza priprave zajema planiranje in organiziranje, faza izvedbe pa vodenje in kontroliranje. Pri planiranju in kontroli časa se poslužujemo orodij, kot so WBS diagram, mrežni in terminski plan, oziroma gantogram in plan virov. Gantogram in plan virov nam služita kot osnova za planiranje in kontrolo stroškov. Le to ima tri faze, in sicer ocenjevanje, planiranje in kontroliranje stroškov, predstavljena pa je tudi metoda EVA.

Z naraščanjem števila in kompleksnosti projektov v organizaciji, je postala informacijska podpora projektom nujno potrebna, če se želi ohraniti zmožnost učinkovitega upravljanja projektov, zato je tu obravnavan tudi najbolj razširjen program namenjen projektnemu managementu Microsoft Office Project. Obenem je predstavljen tudi razvoj računalniško podprtega konstruiranja na področje načrtovanja gradenj in programov za projektni management. Ker IKT tehnologija omogoča obdelavo in generiranje velikanske količine podatkov, je za učinkovito obvladovanje potrebno skupno podatkovno okolje CDE, ki je centralna točka združitve vseh projektnih informacij na enem mestu.

Informacijsko modeliranje gradenj oziroma BIM-pristop je združitev programov za projektni management, CAD računalniškega konstruiranja s prvinami CDE pristopa. Temelj BIM-pristopa je interoperabilnost, ki omogoča izmenjavo datotek med različnimi programi in aplikacijami, ki so namenjeni različnim deležnikom. Odprt podatkovni format IFC interoperabilnost tudi omogoča, za njegovo standardizacijo pa skrbi združenje buildingSMART. BIM-stopnje opisujejo zrelostne stopnje izvajanja projektov in stremijo k čim večji medsebojni integraciji deležnikov projekta, BIM-razsežnosti pa s plemenitenjem 3D-modelov z drugimi, negeometrijskimi podatki, kot so stroški, čas izvedbe ipd. odpiramo nove možnosti, kako pristopiti k izvajanju in managementu gradbenih projektov.

Za osnovo empirične raziskave sem izbral ankete angleškega Nacionalnega odbora za gradbeno specifikacijo (ang. *National Building Specification, NBS*), ki so jih redno izvajali od leta 2011 dalje, z namenom ocene stanja BIM-pristopa v gradbeništvu. Zaradi

dolgoletnega izvajanja je možno primerjati stanje slovenskih anketirancev z angleškimi pred ali po vpeljavi BIM-pristopa v javna naročila.

Rezultati raziskave so pokazali da je struktura zastopanih panog in velikosti podjetij zelo podobna angleški. Anketa je v primerjava z anketami NBS pokazala, da je v Sloveniji visoka stopnja ozaveščenosti obstoja in uporabe BIM-pristopa. Prav tako ne gre zanemariti dejstva, da se Slovenija uvršča med najbolj aktivne države pri akademskem raziskovanju BIM-pristopa in to kljub odsotnosti javnega programa uvajanja BIM-pristopa. Oboje nakazujejo torej na močan pristop implementacije od spodaj navzgor. Visok delež anketirancev pričakovanje, da bo država vpeljala (prisilila) BIM-pristop v javni sektor. Temu naproti, bi morala stopiti tudi država Slovenija in začeti uveljavljati postopen program uvajanja BIM-pristopa za vsa javna naročila. Pri tem se lahko zgleduje po primerih dobrih praks iz tujine, tako VB kot tudi skandinavskih in drugih držav, prav tako pa že obstajajo programi in združenja, ki so lahko v pomoč pri uvajanju BIM-pristopa v zakonodajo ter javni sektor, tako tuja, kot je združenje buildingSMART, kot tudi domača kot je združenje siBIM. A brez lastnih izkušenj in znanja ne gre. Slovenski anketiranci potrebujejo jasen znak, da država kot dober gospodar prepoznava BIM-pristop kot prihodnost izvajanja gradenj, saj se bo to kratkoročno in dolgoročno splačalo obema stranema. Slovensko gradbeni trg je v primerjavi z britanskim majhen, a je to prav tako prednost, saj se stimulira pogostost medsebojnih sodelovanj. Okolje zunaj javnega sistema je že sedaj dovolj razvito, da se lahko izvajajo posamezne državne investicije z uporabo najvišjih stopenj in razsežnosti BIM-pristopa, kar potrjujeta tudi izgradnja Vinariuma v Lendavi in razpis za izvedbo drugega predora Karavanškega tunela. Z uvajanjem specifikacij, referenc in standardov, bi se zagotovila nujno potrebna struktura, preko katere bi se uporabniki BIM-pristopa lahko objektivno samoocenjevali in usmerjali lasten razvoj. Vzpostavil bi se dolgoročen temelj, potreben za uveljavljanje, pridobivanje in širjenje izkušenj ter znanja in posledično dviganje samozavesti, ki bi vodila do hitrejše implementacije, tako v javni kot zasebni sektor.

Za učinkovito vpeljavo BIM-pristopa bi bilo smotrno tudi redno ponavljanje ankete, ki bi jo bilo smiselno skozi leta tudi delno prilagajati trenutnim trendom, tako kot so to storili v angleških raziskavah. Pri ponovitvi bi bilo smotrno podrobno povprašati kakšne koristi BIM-pristop dejansko prinaša pri izvajanju projektov z vidika učinkovite izvedbe, kot so čas in stroški, število napak oz. težav pri izvedbi ter tveganja, pa tudi odgovoriti, zakaj ima četrtinski delež slovenskih anketirancev pozitivno mnenje o vladnih usmeritvah do BIM-pristopa.

Sama implementacija za naročnika in izvajalca ne predstavlja visoke finančne ovire, saj se sama investicija hitro povrne skozi blagodejne učinke zmanjšanih stroškov in časa izvedbe gradbenih projektov. Največji oviri sta osvojitev znanja in sprememba kulture, ki sta nujno potrebni za učinkovito izvajanje BIM-pristopa ter sta tudi najdolgotrajnejša in najzahtevnejša procesa, ki se z denarjem ne moreta kupiti. Samo dovolj velik zunanji vpliv, kot je zavezanost države k osvojitvi BIM-pristopa, bi največ pripomogla k splošni

obravnavi, tudi zunaj gradbene stroke, saj se odpirajo tudi druga vprašanja in dileme kot so zakonodajni, varnostni, sociološki in ekonomski vidiki uporabe.

Veliko slovenskih podjetij že deluje na nepričakovano visokih BIM-stopnjah, zato jim tu ne morem dodati priporočil in ukrepov. Prav tako že obstaja dovolj zrel poslovni in IKT ekosistem, ki vse to omogoča. Dejstvo je, da je BIM-pristop še v fazi razvoja, zato se procesi, standardi in zakonodaje še vedno usklajujejo in prilagajajo novi, moteči tehnologiji, a ker je že sprejeta kot prihodnost izvajanja gradenj tako na domačem kot tudi globalnem tržišču, se je z izzivi, ki nam jih spremembe prinašajo, potrebno aktivno soočiti že danes.

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PRILOGE

KAZALO PRILOG

PRILOGA 1: Anketni vprašalnik

Anketa o uveljavitvi BIM-a v Sloveniji

Kratko ime ankete: Kopija - ANKETA NBS-National-BIM-Report-
Dolgo ime ankete: Anketa o uveljavitvi BIM-a v Sloveniji
Število vprašanj: 20
Anketa še ni bila aktivirana.
Avtor: suntrace1 Spreminjal: suntrace1
Dne: 16.05.2017 Dne: 19.01.2018
Opis: Kopija ankete: ANKETA NBS-National-BIM-Report-2014

V magistrski nalogi raziskujem, kako pomemben je postal BIM za slovensko gradbeništvo in posledično, ali naj podjetja in organizacije tudi sami pričnejo aktivno vpeljevati BIM. Anketa je izdelana po predlogi angleškega gradbenega zavoda NBS, ki je BIM vpeljal kot standard za vsa javna naročila od aprila 2016 dalje, anketo pa so izvajali od leta 2010 vsakoletno. S primerjavo rezultatov želim oceniti, kje se Slovenija nahaja pri vpeljavi BIM-a v primerjavi z Veliko Britanijo. Vaše mnenje pri oblikovanju objektivnega odgovora na ta vprašanja je zelo pomembno, zato vas prosim, če si lahko vzamete največ 5 minut časa za izpolnitev ankete. Anketa se izvaja anonimno in zaupno. Podatki in rezultati se bodo koristili samo v izobraževalne namene. Rezultate bom uporabil za izdelavo magistrske naloge, ki bo po uspešnem zagovoru tudi javno dostopna, tako da boste tudi sami imeli vpogled v pridobljene rezultate. Če imate kakršnakoli vprašanja v zvezi z anketo, me lahko kontaktirate preko spletne pošte sasa.kiraly@gmail.com in z veseljem vam bom odgovoril.

Q1 – Koliko ljudi je zaposlenih v vaši podjetju?

- ○ 1-9
- ○ 10-49
- ○ 50-249
- ○ 250+

Q2 - V katerem panogi deluje vaše podjetje?

- ○ Nizka gradnja
- ○ Visoka gradnja
- ○ Arhitektura
- ○ Strojništvo
- ○ Industrija gradbenega materiala
- ○ Geodezija
- ○ Vzdrževanje objektov
- ○ Prodaja nepremičnin

Q3 - Poznate in uporabljate BIM?

- ○ Poznam in uporabljam BIM
- ○ Samo poznam BIM
- ○ Ne uporabljam BIM-a in ga do te ankete nisem poznal

IF (1) Q3 = [2]
Q4 - Kdaj boste po vašem mnenju uporabljali BIM?

- ○ BIM bomo uporabljali v roku 1 leta
- ○ BIM bomo uporabljali v roku 3 let
- ○ BIM bomo uporabljali v roku 5 let
- ○ Težko ocenim

IF (2) Q3 = [2, 1]
Q5 - Kako zelo se strinjate z naslednjimi trditvami?

	Se ne strinjam	Niti niti	Se strinjam
Zadnje čase se vse več govori o BIM-u	○	○	○
Vlada bo prisilila ljudi k uporabi BIM-a v javnem sektorju	○	○	○
BIM je prihodnost projektnih informacij	○	○	○
Potrebno je, da nam proizvajalci priskrbijo BIM-objekte	○	○	○
Menim da je vlada na pravi poti glede uporabe BIM-a	○	○	○
Če specifikacije izdelka niso povezane z digitalnim modelom, potem to ni BIM	○	○	○
BIM bomo potrebovali za ustvarjanje okolju prijaznih zgradb	○	○	○
Verjamem temu, kar slišim o BIM-u	○	○	○
Informacijski modeli delujejo samo v programih, v katerih so bili ustvarjeni	○	○	○

Q6 - Na katere od naslednjih virov se boste obrnili, v primeru da potrebujete informacijo o BIM-u? (možnih je več odgovorov)

- ☐ Na moje kolege
- ☐ Druge strokovnjake, ki jih poznam zunaj moje organizacije
- ☐ Zavod za gradbeništvo – ZAG
- ☐ Slovensko združenje za informacijsko modeliranje v gradbeništvu - siBIM
- ☐ Zbornico za arhitekturo in prostor Slovenije – ZAPS
- ☐ Svetovalca za BIM
- ☐ Drugo strokovno / profesionalno inštitucijo
- ☐ Proizvajalca CAD programa
- ☐ buildingSMART
- ☐ Zastopnika za CAD program

IF (3) Q3 = [2, 1]
Q7 – Z vidika vašega poznavanja BIM-a, kako zelo se strinjate z naslednjimi trditvami?

	Se ne strinjam	Niti niti	Se strinjam
Industrija trenutno še ni dovolj poenotena glede tega, kaj BIM sploh je	○	○	○
Bistvo BIM-a je v medsebojnem sodelovanju v realnem času	○	○	○
Bistvo BIM-a je programska oprema	○	○	○
BIM je primeren samo za novogradnjo in ne tudi za obnovo objektov	○	○	○
BIM ne omogoča edinstvenega/unikatnega dizajna ali gradbenih metod	○	○	○
Uporaba BIM-a vodi k dolgočasnim/pustim zgradbam	○	○	○
BIM je samo sinonim za 3D CAD risbe	○	○	○

IF (4) Q3 = [1]
Q8 – Kako bi se ocenili kot uporabnik BIM-a?

- ○ Sem napredni uporabnik in bi lahko učil druge
- ○ Kar obvladam
- ○ Sem bolj začetnik

IF (5) Q3 = [2]
Q9 - Kako dobro poznate BIM?

- ○ Zelo dobro
- ○ Dobro
- ○ Slabo

IF (7) Q3 = [1]
Q11 - Kateri je najvišji nivo uporabe BIM-a, ki ga je po vaši oceni dosegla vaša organizacija?

- ○ Nivo3 (integracija podmodelov BIM z uporabo BIM-strežnika)
- ○ Nivo 2 (posamezni BIM-modeli – BIM 3D, BIM 4D, itd.)
- ○ Nivo 1 (CAD2D-risbe, 3D-modeli)
- ○ Nivo 0 (samo CAD 2D-risbe)
- ○ Ne vem

IF (8) Q3 = [1]
Q12 - Katerega od naštetih sestavin BIM-pristopa uporablja vaša organizacija? (možnih je več odgovorov)

- ☐ Imamo organiziran BIM-proces (npr. definirane vloge kot so BIM-manager, BIM-koordinator, itd.)
- ☐ Uporabljamo pravila za informacijske zahteve BIM-pristopa (npr. stopnje razvoja modela v različnih fazah projekta, strukturiranost modelov, itd.)
- ☐ Uporabljamo pravila za tehnične zahteve za BIM-modele (npr. format izmenjave, IT-infrastruktura, itd.)
- ☐ Uporabljamo pravila za predajo BIM-modelov (BIM izvedbeni načrt, načrt za izmenjavo podatkov, itd.)

IF (8) Q3 = [1]
Q13 - Uporabljate IFC (*Industry Foundation Classes*) na vaših projektih?

- ○ Da
- ○ Ne
- ○ Ne vem

IF (8) Q3 = [1]
Q14 - Uporabljate COBie (*Construction Operations Building Information Exchange*) na vaših projektih?

- ○ Da
- ○ Ne
- ○ Ne vem

IF (9) Q3 = [2, 1]
Q15 - Kakšne so ovire pri prevzemu BIM-a? (možnih je več odgovorov)

- [ ] Pomanjkanje strokovnega znanja znotraj organizacije
- [ ] Pomanjkanje izobraževanja
- [ ] Ni zahtev / povpraševanja s strani strank
- [ ] Cena
- [ ] Ni časa za uvajanje
- [ ] Projekti ki jih izvajamo so premajhni za BIM
- [ ] Pomanjkanje orodij s standardiziranimi formati (npr. IFC)
- [ ] Pomanjkanje nacionalnih smernic (npr. smernic za uporabo BIM-a v projektih, standardiziranih popisov)
- [ ] BIM ni relevanten za projekte na katerih delamo
- [ ] Pomanjkanje sodelovanja
- [ ] BIM ni bil strateška prioriteta za organizacijo v kateri sem zaposlen
- [ ] Vprašanje porazdelitve odgovornosti pri BIM pristopu
- [ ] Pomanjkanje prosto dostopnih BIM objektov
- [ ] Pomanjkanje visoko kakovostnih, informacijsko bogatih BIM objektov
- [ ] Ne vidimo koristi/ prednosti
- [ ] Nismo prepričani ali bo industrija prevzela BIM
- [ ] Nismo prepričani o zavezanosti vlade do BIM-a

Q16 - Katero izmed programskih orodij uporabljate večinoma za izdelavo risb?

- ○ AutodeskRevit (Architecture/Structure/MEP)
- ○ Autodesk AutoCAD
- ○ Graphisoft ArchiCAD
- ○ Nemetschek Vectorworks
- ○ Bentley Microstation
- ○ Trimble Sketchup (nekdanji Google Sketchup)
- ○ Bentley Building Suite (Architecture /Mechanical/Electrical/Structural)
- ○ Nemetschek Allplan
- ○ Drugo:

IF (10) Q3 = [1]
Q17 - Kje dobite BIM objekte, ki jih vaša organizacija uporablja? (možnih je več odgovorov)

- [ ] Naredili smo jih znotraj organizacije in jih zdaj znova uporabljamo
- [ ] Naredimo jih, glede na potrebe projekta
- [ ] So že vključeni v naš CAD programski paket
- [ ] Proizvajalci nam jih dobavijo za našo uporabo
- [ ] Uporabljamo generične BIM objekte
- [ ] Uporabljamo angleško NBS BIM knjižnico
- [ ] Uporabljamo drugo BIM knjižnico
- [ ] Kupimo jih od specialista za BIM zunaj naše organizacije

IF (11) Q3 = [2]
Q18 - Kakšno je vaše stališče do BIM-a?

	Da	Ne
Najprej moramo priti skozi recesijo v gradnji, šele potem bomo obravnavali BIM	○	○
BIM je trenutno predrag, da bi ga lahko obravnavali	○	○
Če ne bomo vpeljali BIM-a, bomo izostali / zaostali	○	○

IF (12) Q3 = [2, 1]
Q19 - Ali se strinjate z naslednjimi trditvami?

	Da	Ne	Ne vem
Vpeljava BIM-a zahteva spremembe v delovnem toku, procesih in procedurah	○	○	○
BIM izboljša vizualizacijo	○	○	○
BIM izboljša koordinacijo projektne dokumentacije	○	○	○
Stranke bodo od nas vedno bolj zahtevale vpeljavo BIM-a	○	○	○
Pogodbeniki bodo od nas vedno bolj zahtevali vpeljavo BIM-a	○	○	○
BIM dvigne produktivnost zaradi lažjega dostopa do potrebnih informacij	○	○	○
Vpeljava BIM-a poveča stroškovno učinkovitost	○	○	○
BIM pospeši hitrost izpeljave projekta	○	○	○
Vpeljava BIM-a poveča našo donosnost	○	○	○
BIM je naredil tradicionalne specifikacije odvečne	○	○	○
Raje bi videl, da ne bi/ nismo vpeljali BIM-a	○	○	○

IF (13) Q3 = [1]
Q20 - Ali se strinjate z naslednjimi trditvami o vpeljavi BIM-a v vašo organizacijo?

	Da	Ne
Vpeljava BIM-a nam je dvignila konkurenčno prednost	○	○
BIM smo uspešno vpeljali	○	○

Q21 - Ali ste v zadnjem letu na vaših projektih izdelali sledeče? (možnih je več odgovorov)

- ☐ Izdelali2D digitalne risbe
- ☐ Skupinsko sodelovali na dizajnu / oblikovanju
- ☐ Izdelali 3D digitalne modele
- ☐ Delili BIM modele z ostalimi člani oblikovalskega tima zunaj naše organizacije
- ☐ Uporabili 3D informacijske modele, ki niso vsebovali vseh informacij celotne zgradbe
- ☐ Delili BIM modele med različnimi strokami, znotraj vaše organizacije
- ☐ Uporabljali BIM modele od samega začetka do konca projekta
- ☐ Izdelali BIM model, ki ni bil povsem odvisen od točno določenega programa
- ☐ Predali BIM model tistim, ki so odgovorni za nadaljnjo vzdrževanje zgradbe

PRILOGA 2: Rezultati anketnega vprašalnika

ANALIZA - Sumarnik

Q1	Koliko ljudi je zaposlenih v vaši podjetju?				
	Odgovori	Frekvenca	Odstotek	Veljavni	Kumulativa
	1 (1-9)	55	55%	55%	55%
	2 (10-49)	20	20%	20%	75%
	3 (50-249)	16	16%	16%	91%
	4 (250+)	9	9%	9%	100%
Veljavni	Skupaj	100	100%	100%	
		Povprečje	1,8	Std. Odklon	1

Q2	V katerem panogi deluje vaše podjetje?				
	Odgovori	Frekvenca	Odstotek	Veljavni	Kumulativa
	1 (Nizke gradnje)	19	19%	19%	19%
	2 (Visoke gradnje)	19	19%	19%	39%
	3 (Arhitektura)	47	47%	48%	87%
	4 (Strojništvo)	6	6%	6%	93%
	5 (Industrija gradbenega materiala)	4	4%	4%	97%
	6 (Geodezija)	2	2%	2%	99%
	7 (Vzdrževanje objektov)	1	1%	1%	100%
	8 (Prodaja nepremičnin)	0	0%	0%	100%
Veljavni	Skupaj	98	98%	100%	
		Povprečje	2,7	Std. Odklon	1,2

Q3	Poznate in uporabljate BIM?				
	Odgovori	Frekvenca	Odstotek	Veljavni	Kumulativa
	1 (Poznam in uporabljam BIM)	73	73%	75%	75%
	2 (Samo poznam BIM)	24	24%	25%	100%
	3 (Ne uporabljam BIM-a in ga do te ankete nisem poznal)	0	0%	0%	100%
Veljavni	Skupaj	97	97%	100%	
		Povprečje	1,2	Std. Odklon	0,4

Q4	Kdaj boste po vašem mnenju uporabljali BIM?				
	Odgovori	Frekvenca	Odstotek	Veljavni	Kumulativa
	1 (BIM bomo uporabljali v roku 1 leta)	5	5%	25%	25%
	2 (BIM bomo uporabljali v roku 3 let)	2	2%	10%	35%
	3 (BIM bomo uporabljali v roku 5 let)	4	4%	20%	55%
	4 (Težko ocenim)	9	9%	45%	100%
Veljavni	Skupaj	20	20%	100%	
		Povprečje	2,9	Std. Odklon	1,3

Q5	Kako zelo se strinjate z naslednjimi trditvami?								
	Podvprašanja	Odgovori				Veljavni	Št. enot	Povprečje	Std. Odklon
		Se ne strinjam	Niti niti	Se strinjam	Skupaj				
Q5a	Zadnje čase se vse več govori o BIM-u	3 4%	9 11%	71 86%	83 100%	83	100	2,8	0,47
Q5b	Vlada bo prisilila ljudi k uporabi BIM-a v javnem sektorju	12 14%	34 41%	37 45%	83 100%	83	100	2,3	0,71
Q5c	BIM je prihodnost projektnih informacij	6 7%	7 8%	70 84%	83 100%	83	100	2,8	0,57
Q5d	Potrebno je, da nam proizvajalci priskrbijo BIM-objekte	5 6%	9 11%	68 83%	82 100%	82	100	2,8	0,55
Q5e	Menim da je vlada na pravi poti glede uporabe BIM-a	12 15%	50 61%	20 24%	82 100%	82	100	2,1	0,62
Q5f	Če specifikacije izdelka niso povezane z digitalnim modelom, potem to ni BIM	7 8%	19 23%	57 69%	83 100%	83	100	2,6	0,64
Q5g	BIM bomo potrebovali za ustvarjanje okolju prijaznih zgradb	16 19%	29 35%	38 46%	83 100%	83	100	2,3	0,77
Q5h	Verjamem temu, kar slišim o BIM-u	7 8%	43 52%	33 40%	83 100%	83	100	2,3	0,62
Q5i	Informacijski modeli delujejo samo v programih, v katerih so bili ustvarjeni	42 51%	28 34%	12 15%	82 100%	82	100	1,6	0,73

Q6	**Na katere od naslednjih virov se boste obrnili, v primeru da potrebujete informacijo o BIM-u? (možnih je več odgovorov)**							
	Podvprašanja	Enote					Navedbe	
		Frekvence	Veljavni	% - Veljavni	Ustrezni	% - Ustrezni	Frekvence	%
Q6a	Na moje kolege	49	83	59%	100	49%	49	19%
Q6b	Druge strokovnjake, ki jih poznam zunaj moje organizacije	51	83	61%	100	51%	51	20%
Q6c	Zavod za gradbeništvo – ZAG	2	83	2%	100	2%	2	1%
Q6d	Slovensko združenje za informacijsko modeliranje v gradbeništvu - siBIM	31	83	37%	100	31%	31	12%
Q6e	Zbornico za arhitekturo in prostor Slovenije – ZAPS	6	83	7%	100	6%	6	2%
Q6f	Svetovalca za BIM	29	83	35%	100	29%	29	11%
Q6g	Drugo strokovno / profesionalno inštitucijo	11	83	13%	100	11%	11	4%
Q6h	Proizvajalca CAD programa	23	83	28%	100	23%	23	9%
Q6i	buildingSMART	15	83	18%	100	15%	15	6%
Q6j	Zastopnika za CAD program	41	83	49%	100	41%	41	16%
	SKUPAJ		83		100		258	100%

Q7	**Z vidika vašega poznavanja BIM-a, kako zelo se strinjate z naslednjimi trditvami?**								
	Podvprašanja	Odgovori				Veljavni	Št. enot	Povprečje	Std. Odklon
		Se ne strinjam	Niti niti	Se strinjam	Skupaj				
Q7a	Industrija trenutno še ni dovolj poenotena glede tega, kaj BIM sploh je	10 13%	22 28%	46 59%	78 100%	78	100	2,5	0,72
Q7b	Bistvo BIM-a je v medsebojnem sodelovanju v realnem času	5 6%	24 30%	50 63%	79 100%	79	100	2,6	0,61
Q7c	Bistvo BIM-a je programska oprema	20 26%	32 42%	24 32%	76 100%	76	100	2,1	0,76
Q7d	BIM je primeren samo za novogradnjo in ne tudi za obnovo objektov	59 75%	14 18%	6 8%	79 100%	79	100	1,3	0,61
Q7e	BIM ne omogoča edinstvenega/unikatnega dizajna ali gradbenih metod	63 80%	10 13%	6 8%	79 100%	79	100	1,3	0,6
Q7f	Uporaba BIM-a vodi k dolgočasnim/pustim zgradbam	71 90%	6 8%	2 3%	79 100%	79	100	1,1	0,4
Q7g	BIM je samo sinonim za 3D CAD risbe	67 85%	10 13%	2 3%	79 100%	79	100	1,2	0,45

Q8	**Kako bi se ocenili kot uporabnik BIM-a?**				
	Odgovori	Frekvenca	Odstotek	Veljavni	Kumulativa
	1 (Sem napredni uporabnik in bi lahko učil druge)	23	23%	38%	38%
	2 (Kar obvladam)	24	24%	40%	78%
	3 (Sem bolj začetnik)	13	13%	22%	100%
Veljavni	Skupaj	60	60%	100%	
		Povprečje	1,8	Std. Odklon	0,8

Q9	Kako dobro poznate BIM?				
	Odgovori	Frekvenca	Odstotek	Veljavni	Kumulativa
	1 (Zelo dobro)	2	2%	11%	11%
	2 (Dobro)	11	11%	58%	68%
	3 (Slabo)	6	6%	32%	100%
Veljavni	Skupaj	19	19%	100%	
		Povprečje	2,2	Std. Odklon	0,6

Q11	Kateri je najvišji nivo uporabe BIM-a, ki ga je po vaši oceni dosegla vaša organizacija?				
	Odgovori	Frekvenca	Odstotek	Veljavni	Kumulativa
	1 (Nivo 3 (integracija podmodelov BIM z uporabo BIM-strežnika))	13	13%	22%	22%
	2 (Nivo 2 (posamezni BIM-modeli – BIM 3D, BIM 4D, itd.))	34	34%	57%	78%
	3 (Nivo 1 (CAD 2D-risbe, 3D-modeli))	9	9%	15%	93%
	4 (Nivo 0 (samo CAD 2D-risbe))	1	1%	2%	95%
	5 (Ne vem)	3	3%	5%	100%
Veljavni	Skupaj	60	60%	100%	
		Povprečje	2,1	Std. Odklon	0,9

Q12	Katerega od naštetih sestavin BIM-pristopa uporablja vaša organizacija? (možnih je več odgovorov)							
	Podvprašanja	Enote					Navedbe	
		Frekvence	Veljavni	% - Veljavni	Ustrezni	% - Ustrezni	Frekvence	%
Q12a	Imamo organiziran BIM-proces (npr. definirane vloge kot so BIM-konzulant, BIM-manager, BIM-koordinator, BIM-koordinator podmodelov, BIM-tehnik, itd.)	6	51	12%	100	6%	6	7%
Q12b	Uporabljamo pravila za informacijske zahteve BIM-pristopa (npr. stopnje razvoja modela v različnih fazah projekta, strukturiranost modelov, itd.)	32	51	63%	100	32%	32	36%
Q12c	Uporabljamo pravila za tehnične zahteve za BIM-modele (npr. format izmenjave, IT-infrastruktura, itd.)	29	51	57%	100	29%	29	32%
Q12d	Uporabljamo pravila za predajo BIM-modelov (načrt za izvedbo BIM-pristopa, načrt za izmenjavo podatkov, itd.)	23	51	45%	100	23%	23	26%
	SKUPAJ		51		100		90	100%

Q13	Uporabljate IFC (Industry Foundation Classes) na vaših projektih?				
	Odgovori	Frekvenca	Odstotek	Veljavni	Kumulativa
	1 (Da)	43	43%	73%	73%
	2 (Ne)	13	13%	22%	95%
	3 (Ne vem)	3	3%	5%	100%
Veljavni	Skupaj	59	59%	100%	
		Povprečje	1,3	Std. Odklon	0,6

Q14	Uporabljate COBie (Construction Operations Building Information Exchange) na vaših projektih?				
	Odgovori	Frekvenca	Odstotek	Veljavni	Kumulativa
	1 (Da)	5	5%	9%	9%
	2 (Ne)	47	47%	81%	90%
	3 (Ne vem)	6	6%	10%	100%
Veljavni	Skupaj	58	58%	100%	
		Povprečje	2	Std. Odklon	0,4

Q15	Kakšne so ovire pri prevzemu BIM-a? (možnih je več odgovorov)							
	Podvprašanja	Enote					Navedbe	
		Frekvence	Veljavni	% - Veljavni	Ustrezni	% - Ustrezni	Frekvence	%
Q15a	Pomanjkanje strokovnega znanja znotraj organizacije	46	75	61%	100	46%	46	12%
Q15b	Pomanjkanje izobraževanja	27	75	36%	100	27%	27	7%
Q15c	Ni zahtev / povpraševanja s strani strank	46	75	61%	100	46%	46	12%
Q15d	Cena	28	75	37%	100	28%	28	8%
Q15e	Ni časa za uvajanje	36	75	48%	100	36%	36	10%
Q15f	Projekti ki jih izvajamo so premajhni za BIM	14	75	19%	100	14%	14	4%
Q15g	Pomanjkanje orodij s standardiziranimi formati (npr. IFC)	18	75	24%	100	18%	18	5%
Q15h	Pomanjkanje nacionalnih smernic (npr. smernic za uporabo BIM-a v projektih, standardiziranih popisov)	44	75	59%	100	44%	44	12%
Q15i	BIM ni relevanten za projekte na katerih delamo	12	75	16%	100	12%	12	3%
Q15j	Pomanjkanje sodelovanja	24	75	32%	100	24%	24	6%
Q15k	BIM ni bil strateška prioriteta za organizacijo v kateri sem zaposlen	13	75	17%	100	13%	13	4%
Q15l	Vprašanje porazdelitve odgovornosti pri BIM pristopu	5	75	7%	100	5%	5	1%
Q15m	Pomanjkanje prosto dostopnih BIM objektov	13	75	17%	100	13%	13	4%
Q15n	Pomanjkanje visoko kakovostnih, informacijsko bogatih BIM objektov	17	75	23%	100	17%	17	5%
Q15o	Ne vidimo koristi/ prednosti	7	75	9%	100	7%	7	2%
Q15p	Nismo prepričani ali bo industrija prevzela BIM	3	75	4%	100	3%	3	1%
Q15q	Nismo prepričani o zavezanosti vlade do BIM-a	18	75	24%	100	18%	18	5%
	SKUPAJ		75		100		371	100%

Q16	Katero izmed programskih orodij uporabljate večinoma za izdelavo modelov?				
	Odgovori	Frekvenca	Odstotek	Veljavni	Kumulativa
	1 (Autodesk Revit (Architecture/Structure/MEP))	11	11%	14%	14%
	2 (Autodesk AutoCAD)	9	9%	11%	25%
	3 (Graphisoft ArchiCAD)	38	38%	48%	73%
	4 (Nemetschek Vectorworks)	0	0%	0%	73%
	5 (Bentley Microstation)	1	1%	1%	75%
	6 (Trimble Sketchup (nekdanji Google Sketchup))	5	5%	6%	81%
	7 (Bentley Building Suite (Architecture /Mechanical/Electrical/Structural))	0	0%	0%	81%
	8 (Nemetschek Allplan)	5	5%	6%	87%
	9 (Drugo:)	10	10%	13%	100%
Veljavni	Skupaj	79	79%	100%	
		Povprečje	3,9	Std. Odklon	2,6

Q16_9_text	Q16 (Drugo:)				
	Odgovori	Frekvenca	Odstotek	Veljavni	Kumulativa
	ptc creo	1	1%	11%	11%
	ida ice	1	1%	11%	22%
	ne izdelujemo bim modelov - smo informatiki	1	1%	11%	33%
	civil 3d, allplan, revit	1	1%	11%	44%
	bricscad, cgs plateia	1	1%	11%	56%
	autodesk civil 3d	1	1%	11%	67%
	plateia	3	3%	33%	100%
Veljavni	Skupaj	9	9%	100%	

Q17	Kje dobite BIM-objekte, ki jih vaša organizacija uporablja? (možnih je več odgovorov)							
	Podvprašanja	Enote					Navedbe	
		Frekvence	Veljavni	% - Veljavni	Ustrezni	% - Ustrezni	Frekvence	%
Q17a	Naredili smo jih znotraj organizacije in jih zdaj znova uporabljamo	20	55	36%	100	20%	20	14%
Q17b	Naredimo jih, glede na potrebe projekta	24	55	44%	100	24%	24	16%
Q17c	So že vključeni v naš programski paket za CAD	27	55	49%	100	27%	27	18%
Q17d	Proizvajalci nam jih dobavijo za našo uporabo	18	55	33%	100	18%	18	12%
Q17e	Uporabljamo generične BIM-objekte	29	55	53%	100	29%	29	20%
Q17f	Uporabljamo angleško NBS BIM-knjižnico	3	55	5%	100	3%	3	2%
Q17g	Uporabljamo drugo BIM-knjižnico	23	55	42%	100	23%	23	16%
Q17h	Kupimo jih od specialista za BIM zunaj naše organizacije	4	55	7%	100	4%	4	3%
	SKUPAJ		55		100		148	100%

Q18	Kakšno je vaše stališče do BIM-a?							
	Podvprašanja	Odgovori			Veljavni	Št. enot	Povprečje	Std. Odklon
		Da	Ne	Skupaj				
Q18a	Najprej moramo priti skozi recesijo v gradnji, šele potem bomo obravnavali BIM	5 26%	14 74%	19 100%	19	100	1,7	0,45
Q18b	BIM je trenutno predrag, da bi ga lahko obravnavali	7 39%	11 61%	18 100%	18	100	1,6	0,5
Q18c	Če ne bomo vpeljali BIM-a, bomo izostali / zaostali	14 74%	5 26%	19 100%	19	100	1,3	0,45

Q19	Ali se strinjate z naslednjimi trditvami?								
	Podvprašanja	Odgovori				Veljavni	Št. enot	Povprečje	Std. Odklon
		Da	Ne	Ne vem	Skupaj				
Q19a	Vpeljava BIM-a zahteva spremembe v delovnem toku, procesih in procedurah	73 95%	2 3%	2 3%	77 100%	77	100	1,1	0,35
Q19b	BIM izboljša vizualizacijo	55 72%	15 20%	6 8%	76 100%	76	100	1,4	0,63
Q19c	BIM izboljša koordinacijo projektne dokumentacije	70 91%	2 3%	5 6%	77 100%	77	100	1,2	0,51
Q19d	Stranke bodo od nas vedno bolj zahtevale vpeljavo BIM-a	37 50%	15 20%	22 30%	74 100%	74	100	1,8	0,88
Q19e	Pogodbeniki bodo od nas vedno bolj zahtevali vpeljavo BIM-a	39 51%	8 11%	29 38%	76 100%	76	100	1,9	0,94
Q19f	BIM dvigne produktivnost zaradi lažjega dostopa do potrebnih informacij	50 66%	14 18%	12 16%	76 100%	76	100	1,5	0,76
Q19g	Vpeljava BIM-a poveča stroškovno učinkovitost	53 71%	9 12%	13 17%	75 100%	75	100	1,5	0,78
Q19h	BIM pospeši hitrost izpeljave projekta	40 53%	16 21%	20 26%	76 100%	76	100	1,7	0,85
Q19i	Vpeljava BIM-a poveča našo donosnost	26 35%	20 27%	28 38%	74 100%	74	100	2	0,86
Q19j	BIM je povzročil, da je klasična projektna naloga nepotrebna	10 13%	53 70%	13 17%	76 100%	76	100	2	0,55
Q19k	Raje bi videl, da ne bi/ nismo vpeljali BIM-a	3 4%	66 87%	7 9%	76 100%	76	100	2,1	0,36

Q20	Ali se strinjate z naslednjimi trditvami o vpeljavi BIM-a v vašo organizacijo?							
	Podvprašanja	Odgovori			Veljavni	Št. enot	Povprečje	Std. Odklon
		Da	Ne	Skupaj				
Q20a	Vpeljava BIM-a nam je dvignila konkurenčno prednost	44 79%	12 21%	56 100%	56	100	1,2	0,41
Q20b	BIM smo uspešno vpeljali	37 67%	18 33%	55 100%	55	100	1,3	0,47

Q21	Ali ste v zadnjem letu na vaših projektih izdelali sledeče? (možnih je več odgovorov)							
	Podvprašanja	Enote					Navedbe	
		Frekvence	Veljavni	% - Veljavni	Ustrezni	% - Ustrezni	Frekvence	%
Q21a	Izdelali 2D digitalne risbe	49	75	65%	100	49%	49	16%
Q21b	Skupinsko sodelovali na dizajnu / oblikovanju	36	75	48%	100	36%	36	12%
Q21c	Izdelali 3D digitalne modele	64	75	85%	100	64%	64	21%
Q21d	Delili BIM modele z ostalimi člani oblikovalskega tima zunaj naše organizacije	31	75	41%	100	31%	31	10%
Q21e	Uporabili 3D informacijske modele, ki niso vsebovali vseh informacij celotne zgradbe	38	75	51%	100	38%	38	12%
Q21f	Delili BIM modele med različnimi strokami, znotraj vaše organizacije	28	75	37%	100	28%	28	9%
Q21g	Uporabljali BIM modele od samega začetka do konca projekta	33	75	44%	100	33%	33	11%
Q21h	Izdelali BIM model, ki ni bil povsem odvisen od točno določenega programa	20	75	27%	100	20%	20	7%
Q21i	Predali BIM model tistim, ki so odgovorni za nadaljnjo vzdrževanje zgradbe	8	75	11%	100	8%	8	3%
	SKUPAJ		75		100		307	100%

PRILOGA 3: Rezultati NBS ankete 2011

BIM survey: summary of findings

Introduction

In September and October 2010, NBS carried out a research project into the UK construction industry's attitude towards Building Information Modelling (BIM). We did the research using an online survey. More than 6,500 people received an invitation to take part. Around 400 people completed the survey, a response rate of 6 per cent.

NBS used its extensive database of those in the construction industry to make sure that a broad range of professions was represented. Of those who took part in the research, 40 per cent were architects, 11 per cent were from multi-disciplinary firms, and 10 per cent were from the public sector (including Local Government). Some other professions that took part included architectural technologists and technicians, building surveyors, quantity surveyors, and manufacturers as well as structural, civil and service engineers.

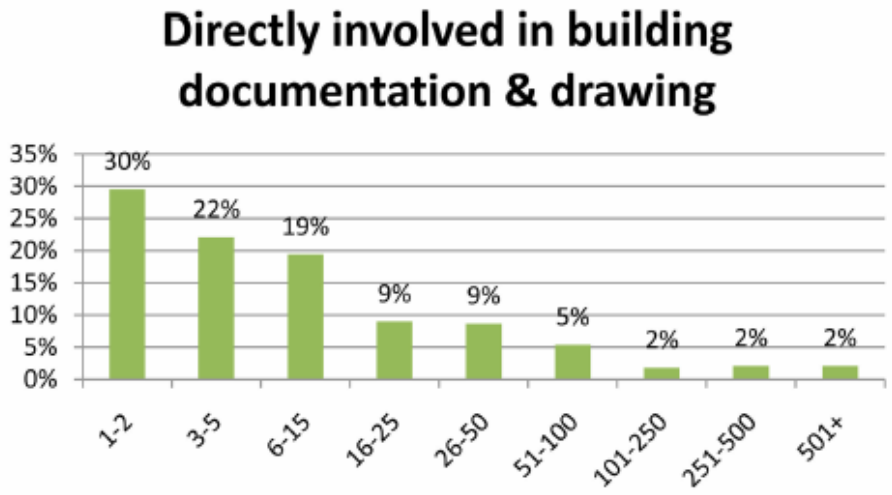
A range of business sizes also was represented. A quarter of those who took part were working in places that had only one or two employees. At the other end of the scale, 12 per cent of those who took part worked in firms with more than 500 employees.

Including yourself, approximately how many people are employed in your organisation?

This range in employee numbers was complemented by the range in the number of those who were involved directly in building documentation and drawing, within the organisation, as shown below.

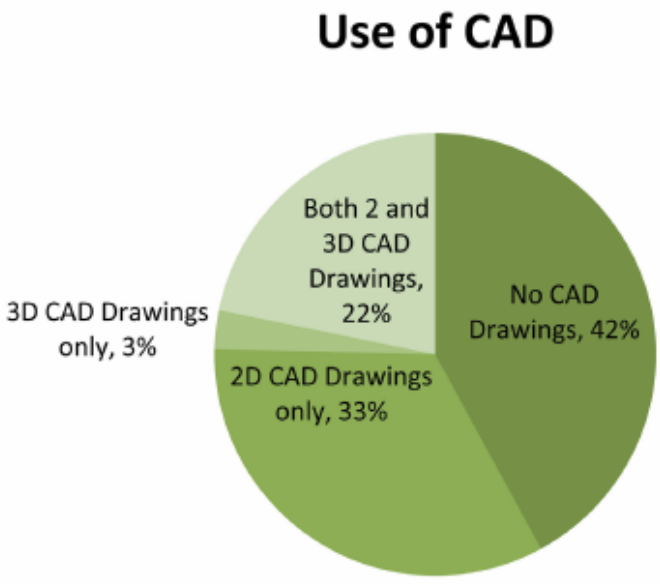
7

Including yourself, approximately how many people in your organisation are directly involved in building documentation & drawing?



CAD

The survey did not approach the topic of BIM adoption straight away, but started with questions about working practice and the use of CAD. By taking this approach we found that CAD usage among individuals is widespread, but not universal. 3D CAD is used by just under a quarter, a third use only 2D CAD. 42 per cent do not use CAD at all.



There were a range of comments about CAD and they reflected the differences in the depth of usage:

'I have used 3D CAD for over twenty years'

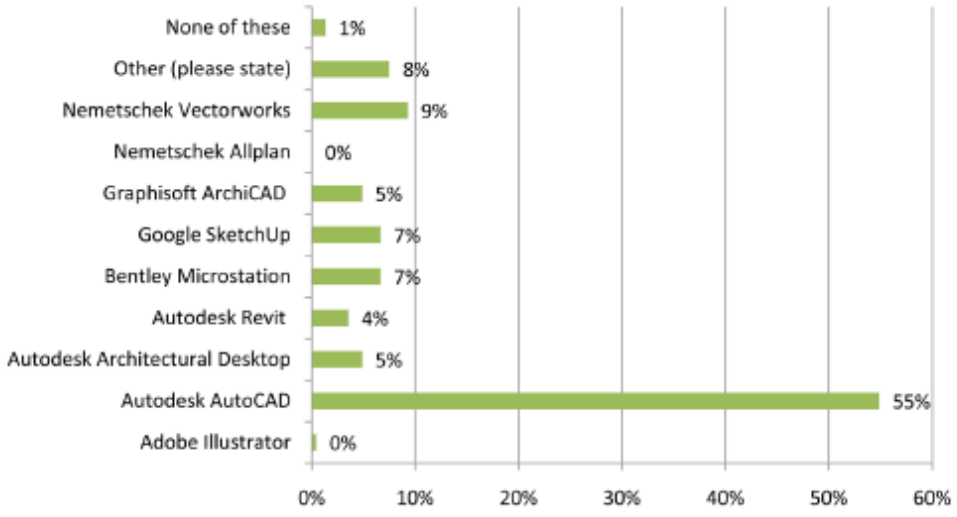
'We use CAD only to produce neat plan drawings'

'I draw by hand and this is unlikely to change'

We found out from those who use CAD, which packages they used, both their 'mainly used' package, and any other package they used.

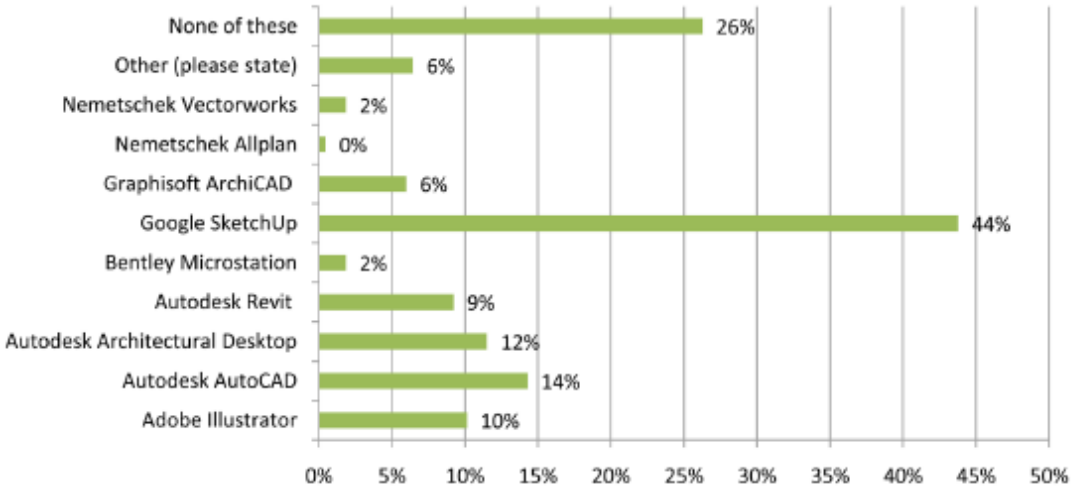
Autodesk AutoCAD is the most 'mainly used' package with 55 per cent of CAD users saying it is their drawing tool of choice. There is no one vendor that has an exclusive hold on the market though, with other drawing tools hovering around the 5 to 10 per cent share.

When producing CAD drawings, which of the following tools do you mainly use?



When looking at other packages people use, Google SketchUp turned out to be very popular. 44 per cent of CAD users are using it as a complementary tool.

When producing CAD drawings, which of the following tools do you also use?



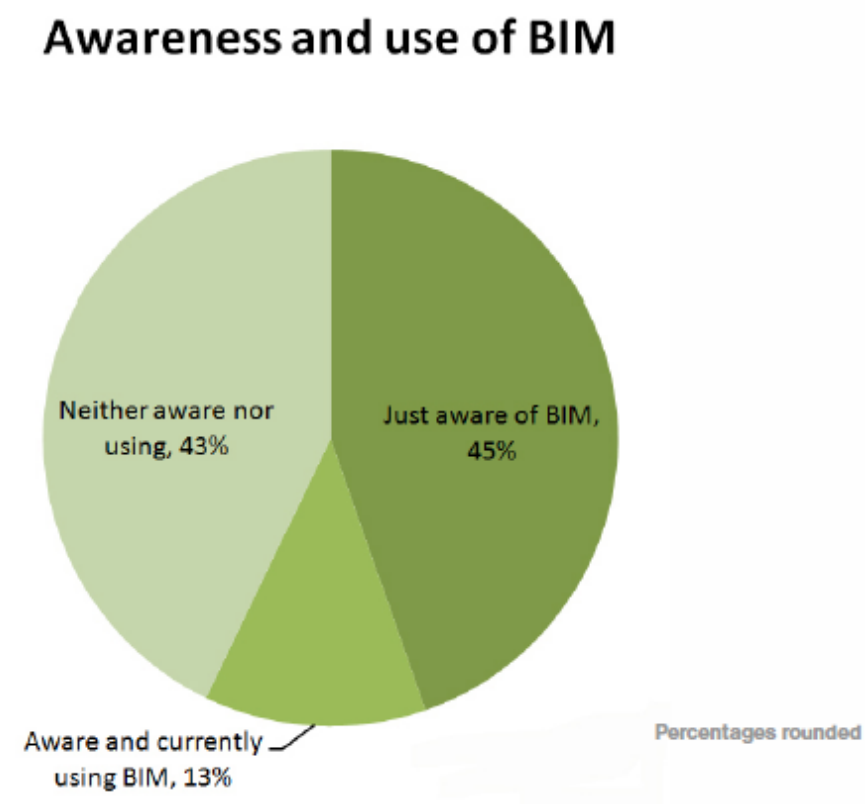
The comments suggested that Google SketchUp is particularly useful early on in a project, especially for working with clients.

'Google SketchUp has been used for early concept sketches for client presentations'.

BIM

BIM now: Use and Awareness of BIM

We asked all those who took part in the survey, 'Have you ever heard of BIM (Building Information Modelling)?' The response showed that BIM is not universally known of, let alone used. 58 per cent are aware of BIM and, among them, 13 per cent are using it. But that leaves a significant proportion, 43 per cent, who are neither using nor aware of BIM. Further analysis of the data was unable to uncover any significant correlation between company size or type and BIM awareness.



What is BIM?

At NBS we describe a Building Information Model (BIM) as a **rich information model**, consisting of potentially **multiple data sources**, elements of which can be **shared** across **all stakeholders** and be maintained across the life of a building from inception to recycling (cradle to cradle). The information model can include **contract and specification properties, personnel, programming, quantities, cost, spaces** and **geometry**.

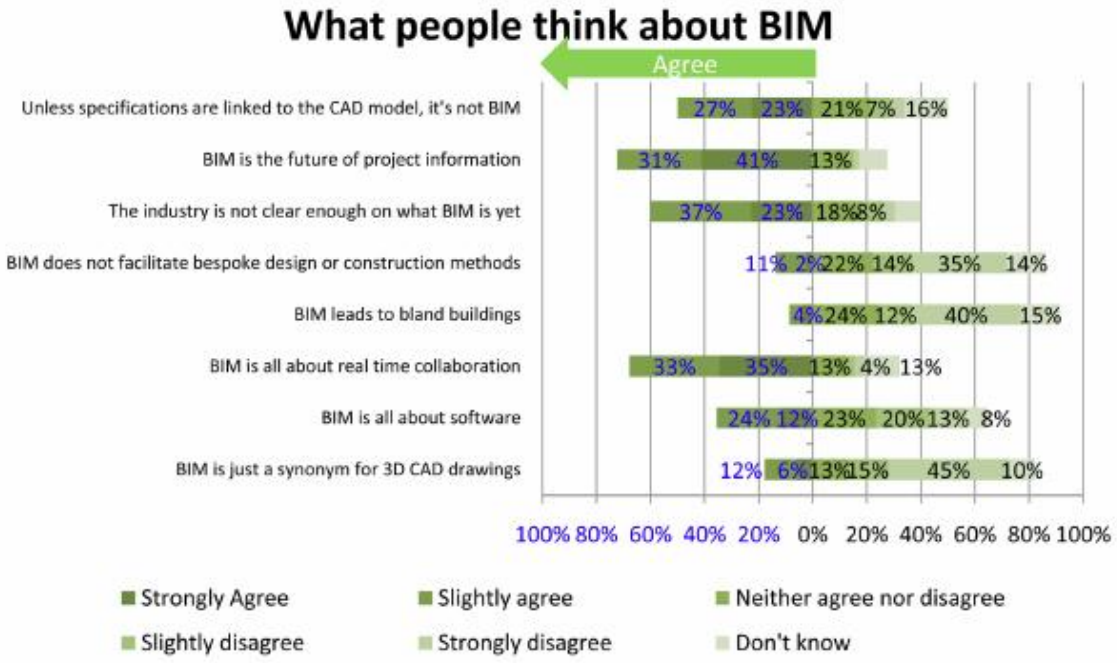
We asked those who were aware of BIM to tell us, in their own words, what 'BIM' meant. The responses were sufficiently diverse to suggest that the industry has yet to agree on a single definition of BIM.

'I have heard of it, but have forgotten what it is... at least I'm honest!'

'Building Information Modelling is the process of creating and using electronic data models of buildings to facilitate a co-ordinated understanding of a broad range of real world building issues, both as a design/specification tool and as an analytical tool for achieving statutory approvals or client driven performance requirements.'

The picture below shows the type of words people chose to use when describing BIM. The larger the word, the more often it was used.

We also asked them to agree or disagree with a set of statements about BIM, and this is what they told us:



11

64 per cent per cent don't agree that BIM is all about the software. Only 18 per cent agree that 'BIM' is a synonym for 3D CAD drawings. So we can see that there is a pretty clear understanding that BIM is not just about the software or CAD drawings (though they may well, c course, be involved in the creation of an information model).

There is general agreement that BIM doesn't lead to bland buildings (only 9 per cent agree) or stand in the way of bespoke design (only 13 per cent agree that 'BIM does not facilitate bespok design or construction methods').

'It is a different way of doing things and expands the possibilities of feasible design'

BIM *is* about collaboration and it does involve specifications.

'[BIM is a] comprehensive combination of drawings, specification and schedules'

Having said that, when it comes to exactly what BIM is, there's agreement (60 per cent agree) that the construction industry is not clear enough yet. Indeed, at the time of writing Wikipedia stated that its entry on BIM 'may be confusing or unclear to readers'.

What people do seem to be clear on, though, is that BIM is the future of project information.

'BIM is the future of construction'

Some are living in that future, so let's turn now to those who are already using BIM.

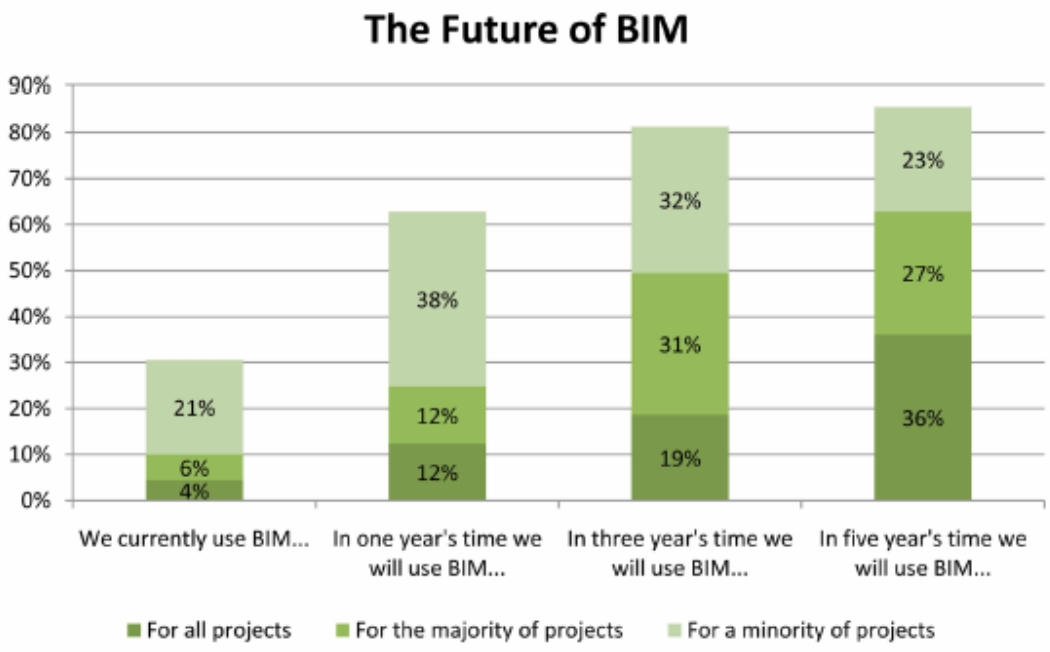
BIM in the Future

How might it work in the future for those not using it now?

It's often said that BIM is the future. Some of those who contributed to the research said it too.

'It's the future for information on complex projects.'

We wanted to see if this is a widespread belief, and whether people currently intend to adopt BIM any time soon.



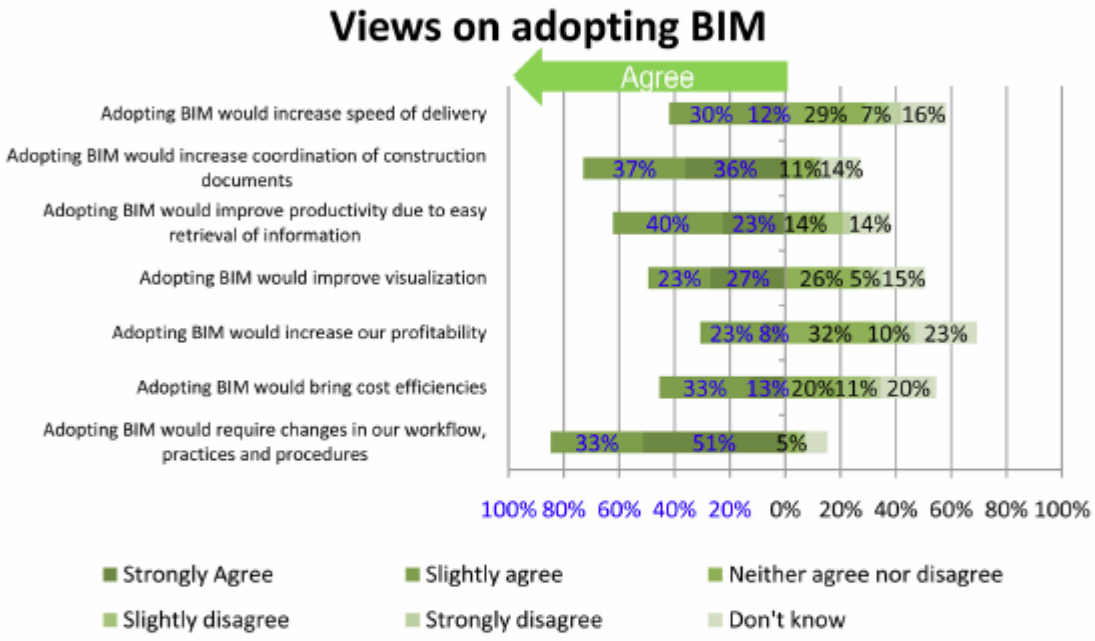
12

We found that *if people carry out their intentions*, a significant majority of those who are aware of BIM will be using it in one year's time for at least a minority of their projects. Within five years, over 85 per cent will.

The intention to adopt BIM is being brought about both by internal and external factors.

Externally, 57 per cent of those currently using BIM and 32 per cent of those aware of BIM feel that contractors will increasingly 'insist on us using BIM'. 67 per cent of those currently using BIM and 29 per cent of those aware of BIM think clients will.

There are internal reasons too. Those that see themselves adopting BIM have a broadly positive picture of it, like those who have already adopted BIM. Generally, those who are yet to adopt BIM believe that it will bring better co-ordination of construction documents, improve productivity, increase delivery speed and improve visualisation. That said, there is a strong appreciation that BIM brings change; 84 per cent agree that 'adopting BIM would require changes in our workflow, practices and procedures'



So, given the perceived advantages are there, what's stopping organisations adopting BIM? Well, the recession has been particularly hard for our construction industry and it is a reason. Almost half say they need to get through the recession before considering BIM.

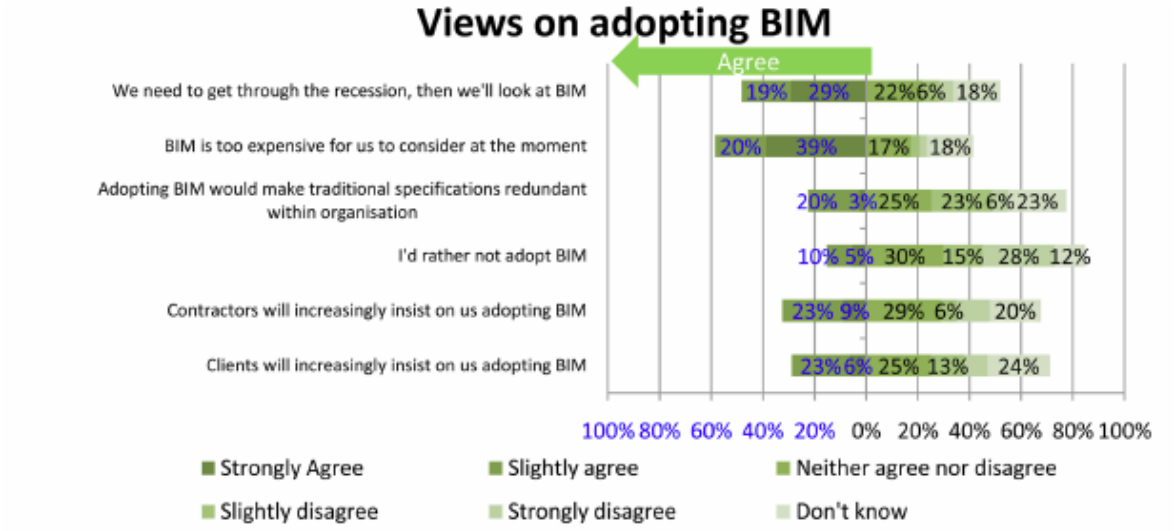
'We are just focused on getting through the recession at present.'

Cost too is a reason with a majority stating that BIM is 'too expensive to consider at the moment'.

'In the current context of required cost savings, BIM would be unviable.'

People are not shying away from BIM though, and very few saying they would 'Rather not adopt BIM'

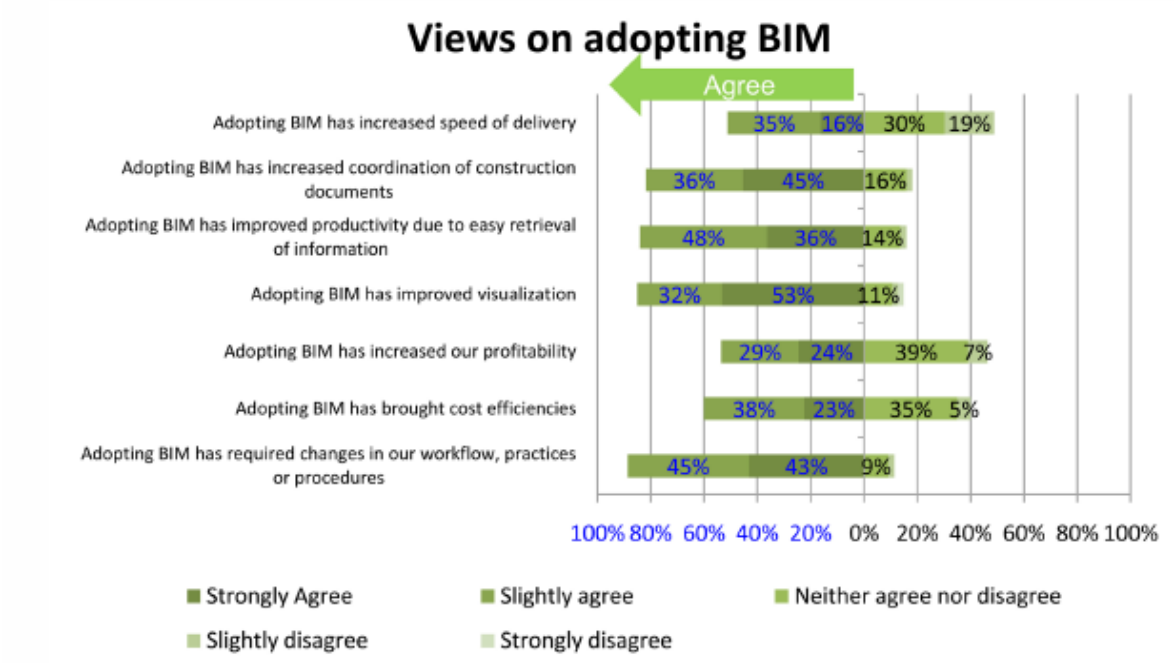
'All things considered, there is no better time to adopt a new technological advance'



BIM now: How it's worked for those using it

Those who are using BIM told us how they were finding it. Because only 13 per cent currently use BIM, our sample is small, so the findings should be treated as indicative and not definitive.

BIM users agree that using BIM brings better co-ordination of construction documents (81 per cent agree), improves productivity, (84 per cent), increases delivery speed (51 per cent) and improves visualisation (85 per cent). To get these gains through BIM, nearly 90 per cent of people have needed to change their workflow, practices and procedure; adopting BIM is not just a matter of buying and using some software.



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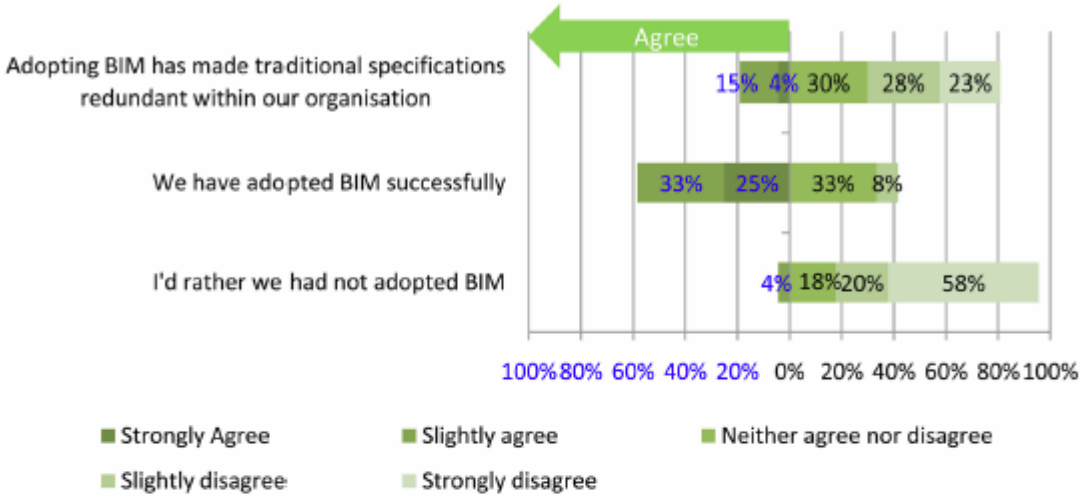
So, adopting BIM has, overall, been a positive experience, with very few, only 4 per cent, wishing they had not adopted BIM. The majority say they have adopted it successfully.



End Note

Our research gives some pretty unambiguous findings.

The industry is not clear on BIM. Many people within are unaware of it. That said, people do understand that BIM is not just CAD. BIM is about collaboration and needs to include specifications.

BIM is the future. Those who are aware of it can see the advantages of adopting it. Cost and the current difficult market stand in the way, but within 5 years over 85 per cent of those who are aware of BIM see themselves adopting it for at least some of their projects.

It looks like it might pay to get on board sooner rather than later.

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PRILOGA 4: Rezultati NBS ankete 2012

BIM Survey: Summary of findings

Adrian Malleson; Research and Analysis Manager, NBS

Introduction

In October and November 2011, NBS followed up their 2010 BIM research* with a further survey. The survey was similar to the last one so that we could make comparisons; we thought it useful to track how people's attitudes towards and use of BIM had changed over the last year.

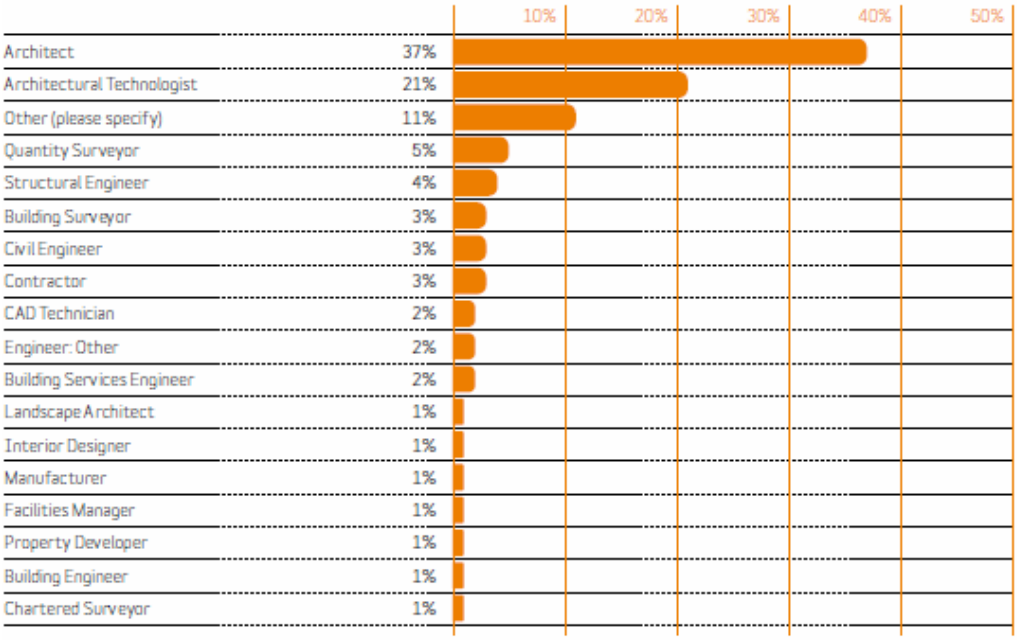
Once again, we did the research using an online survey. This year there were around 1,000 respondents, more than double the number we had last year. Our thanks to everyone who took the time to respond: it's most appreciated and we do take the time to read and consider all the comments.

This year, as the numbers reflect, we extended the reach of the survey beyond those we contacted last year. We were fortunate to have the help of various institutes and associations in promoting participation in the survey to their members. Whilst architects are still the largest group, this has resulted in a broader range of participants, as you can see below. We think this is important because if BIM is to be a tool for collaboration, we need the views of all those in the design team (and beyond). One word of caution, though; because the response sample is different this year, comparisons we make with last year's findings should be read as indicative rather than definitive.

As well as a range of disciplines, the respondents also came from a range of business sizes, with a quarter coming from very small organisations (one or two employees) and 14% coming from very large businesses (more than 500 employees). A majority, 52%, of respondents came from organisations with 15 or fewer employees.

The organisations respondents come from also offer a diverse range of services, with a majority offering specification, contract administration, planning, tendering, project management and Building Regulations services. Three quarters offer a detailed drawing service, whilst half are now offering 3D computer modelling services.

What is your main discipline?



CAD usage

Before asking people about BIM, we wanted to get an understanding of their personal CAD usage. Unsurprisingly, we found that most people use CAD in one form or another – but not all. Whilst a third use 3D CAD (though only 4% use 3D CAD only), 30% are using only 2D and 35% are not using CAD.

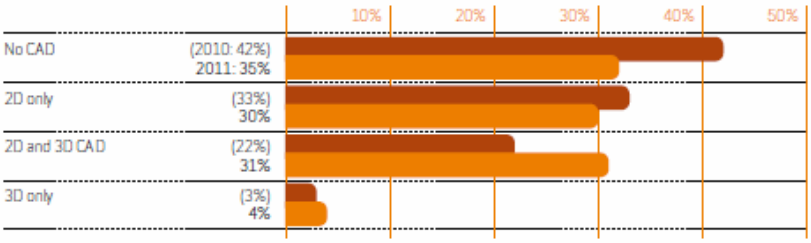
CAD drawing: types done

No CAD	35%
3D only	4%
2D and 3D CAD	31%
2D only	30%

Usage varied significantly by discipline, for example, 82% of architects and 90% of architectural technologists were personally involved in producing CAD drawings, whilst only 5% of quantity surveyors were.

We also found that, compared to last year, fewer people were not using CAD, (down from 42% to 35%) and more were using 3D CAD (35%), though typically along with 2D CAD. Just under a third only use 2D CAD.

Use of CAD: comparison



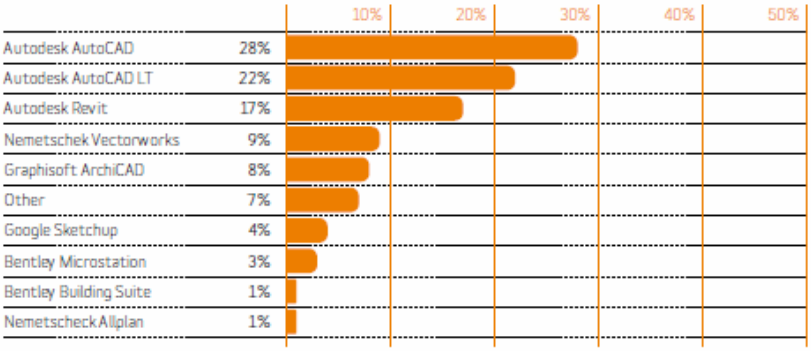
3D CAD was often described as a central to deep, co-ordinated building documentation, and integral to BIM.

"I produce drawings in 3D to show detailed analysis of potential clashing of construction items"

"BIM is the production of a co-ordinated parametric 3D model of your project"

We also asked those using CAD which package they were mainly using. We found that Autodesk, in one form or another, accounted for over two-thirds of the "mainly used" CAD packages.

When producing CAD drawings, which of the following tools do you mainly use?



* http://www.thenbs.com/topics/bim/articles/nbsNationalBimSurvey.asp

When it comes to the use of object-orientated CAD tools, we find that usage has increased marginally, from 39% of total CAD packages used to 42%, though such a small change may be a result of sampling. We can see the reported share of object-orientated CAD tools in the graph below.

Share of usage between various object-orientated CAD tools

Autodesk Revit	55%
Nemetschek Vectorworks	15%
Graphisoft ArchiCAD	15%
Bentley Microstation/Building Suite	15%

Awareness and use of BIM

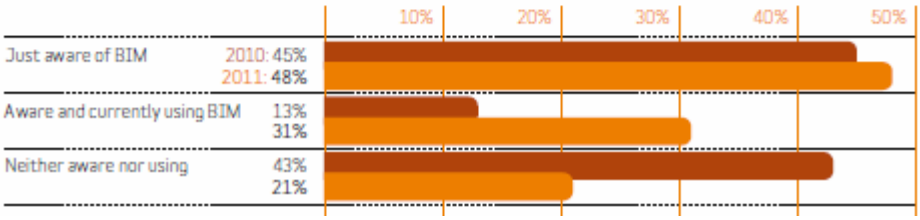
Just aware of BIM	48%
Aware and currently using BIM	31%
Neither aware nor using	21%

BIM now: current use and awareness

Again this year we wanted to find out people's awareness and use of BIM. We did this by asking: "Before taking this survey had you ever heard of BIM (Building Information Modelling)?" We found that awareness of BIM is not universal, with 21% telling us that they were not aware of BIM.

But when we compare the 2011 findings to 2010's, it's clear the tide is turning. In 2010, 13% of respondents told us they were currently using BIM. This has risen by 18 percentage points to 31% in 2011. So, more than double the number of people report using BIM this year than last.

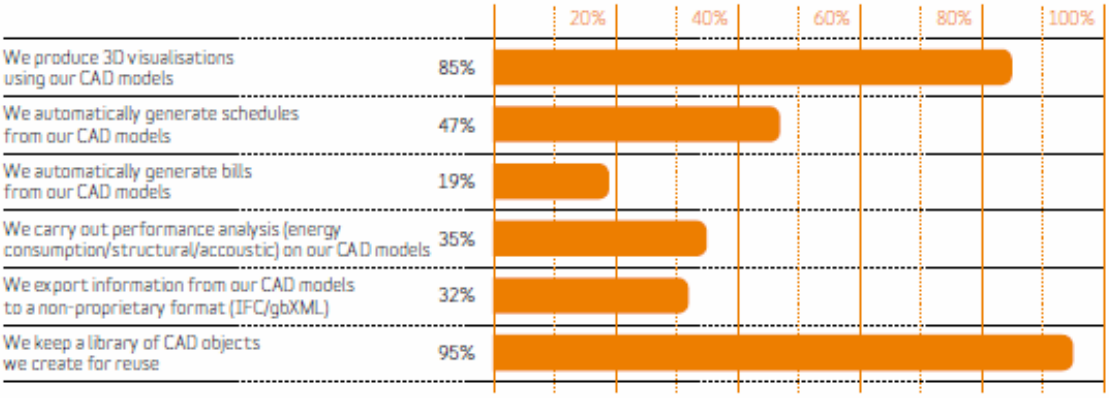
Awareness of BIM has also risen. Last year 43% told us they were unaware of BIM but this year the figure has more than halved with 21% telling us they are unaware of BIM.



Uses of CAD Models

When looking at respondents that say they use CAD, we can see that they are using their models for a variety of different purposes. For example, 35% use CAD models to carry out energy performance analysis, 47% are automatically generating schedules. Almost all respondents, 95%, keep a library of CAD objects, whilst 85% use them to produce 3D visualisations (though not necessarily 3D CAD models). A third of people, 32%, export their information into a non-proprietary format.

Your organisation's use of CAD?

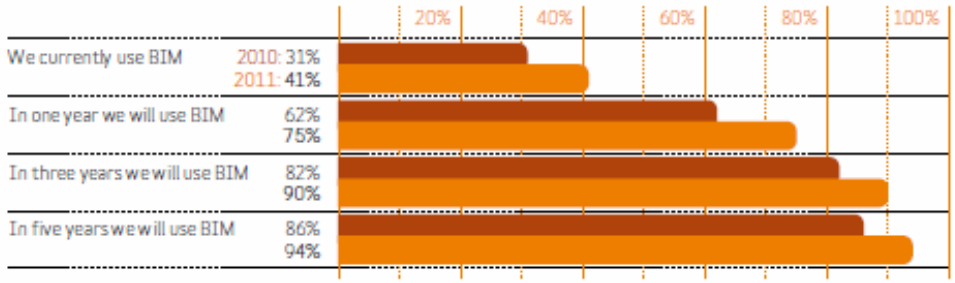


BIM in the future: predicted use

"BIM is the future for the industry." This increased adoption is a trend people expect to continue. We asked **only those who were aware** of BIM whether they expected to be using it for **at least some** of their projects at various points in the future. Three quarters expect to be using BIM in one year's time, and almost 19 out of 20 people expect to be using it in five years' time.

By the end of 2012 three quarters of those currently aware of BIM predict they will be using it on some projects. This is more than last year. Having said that, people's expectations aren't always realised. In 2010, 62% expected to be using BIM in 2011, but only 41% have told us they are actually doing so.

Projected use of BIM among those aware of it



BIM: expectation and reality

Why not adopt BIM? Broadly speaking, people anticipate BIM being a positive move, and it often turns out that way. So what stands in the way? We asked people who had not adopted BIM, but who were aware of it, to answer a couple of questions, shown below.

From your understanding of BIM, how strongly do you agree or disagree with the following statements?

The construction industry is experiencing one of its worst contractions and this is having an effect. When asked, 48% say they "need to get through the downturn" before looking at BIM and 63% agree that BIM is "too expensive".

"I am concerned about the financial and time commitment from a small practice"

"The industry is in a mess"

Further, some small practices saw BIM as unnecessary or as a threat:

"As a sole practitioner, I generally work on small scale residential projects and do not see any fundamental benefit in changing to BIM"

But other small practices are more hopeful:

"For me, as a sole practitioner with aspirations to grow into a small practice, it's all about working smarter – doing more for less"

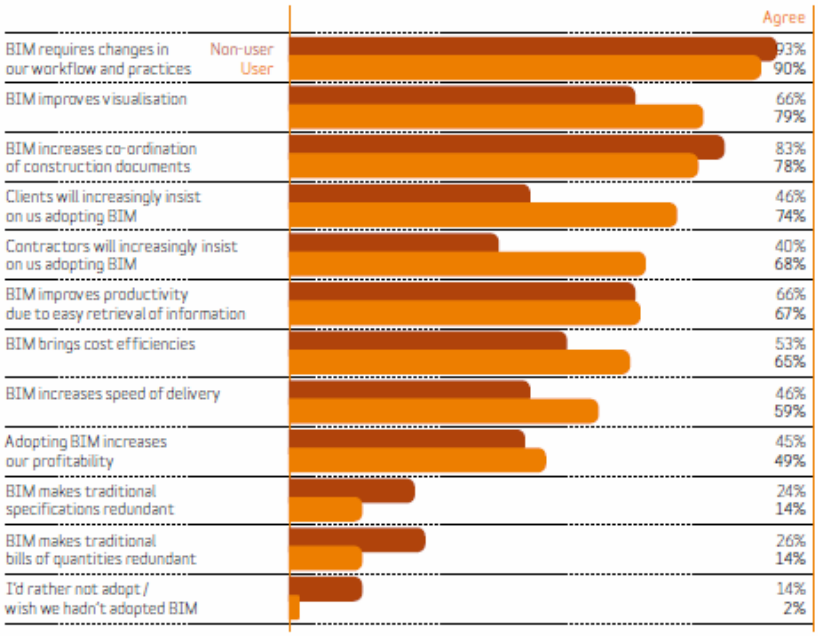
Other respondents feel the downturn may be just the time to adopt BIM:

"Although the downturn has made it difficult to afford the changeover to BIM software, it is also a good time to make the move in order to allow the time for training and implementation"

We were able to compare the views of those who had already adopted BIM, for at least some projects, and those who were aware of BIM, but had yet to adopt it. This helps us understand how expectations compare to experience.

What we found suggests that adopting BIM, very broadly speaking, turns out better than people anticipate. The negatives are less negative and the positives more positive.

Attitudes towards BIM.
A comparison of those who use it, and those who don't



"BIM is worth the initial effort, investment and training"

Clearly adopting BIM requires changes in workflow, practices and procedures, but those changes have generally brought about greater benefit than people anticipate.

"Adopting a BIM process requires a significant adjustment to the way many tasks are undertaken in the industry"

Several respondents stressed that this adjustment was not about software or systems but about people's practices:

"Adopting BIM is all about the people and training"

It's also clear that BIM increases co-ordination and productivity through information retrieval, though the expectation is closer to experience here.

Once BIM is adopted though, it's clear that it makes neither bills of quantities nor specifications redundant.

Those who have adopted BIM are more likely to agree that BIM brings improved visualisation, cost efficiencies and speed of delivery. They are also more likely to agree that external demands will be made for BIM to be adopted, whether from clients or contractors. If this is the case, those not adopting BIM may be putting themselves at a competitive disadvantage.

End note

The use and awareness of BIM is increasing, but the current economic situation and cost stand in the way. From those who have adopted BIM, it looks like BIM presents real commercial opportunities and the current climate might be the right time to adopt.

"As part of a larger architectural organisation, BIM is being considered very seriously. A few of our partner offices are beginning to use BIM, have been asked to use BIM by clients and will need to use BIM in bidding for large or public projects"

Very few people wish they hadn't adopted BIM. Some who haven't, a small minority, would still rather not. Yet looking at the assessment of those who have adopted BIM, perhaps the transition process is not so onerous and the rewards may be greater than first thought.

Last year we suggested "BIM is the future... It looks like it might pay to get on board sooner rather than later". We might now say that BIM is increasingly the present and it might be best not to get left behind.

PRILOGA 5: Rezultati NBS ankete 2013

BIM Survey: Summary of findings

Adrian Malleson
Research and Analysis Manager, NBS

Use of CAD: comparison

No CAD	36%
2D only	25%
2D and 3D CAD	35%
3D only	4%

Introduction

Following our 2011[1] and 2012[2] reports, here is our third set of research findings into BIM and the UK construction industry. We carried out the research in late 2012 and early 2013. We're pleased to say that we've had the largest number of survey responses yet; this year we've had over 1,350 responses compared to around 1,000 in 2011 and 500 in 2010. This level of response reflects the importance of BIM to the industry. It also shows the need for dispassionate reporting of what's really going on. We aim to provide that.

As ever, we're very grateful to those of you who took the time to complete the survey – without the responses there could, of course, be no report. The free text responses are fascinating and they are used in this report to illustrate some of the main findings. We're also grateful to the many professional bodies that publicised the survey to their membership. This kind of assistance is vital to providing a rounded set of findings where all professions have a chance to put forward their view – particularly as collaboration is at the heart of BIM.

Whilst architects remain the largest group of respondents – they make up over a over a third – there are significant other groups, including architectural technologists, (14.4%), building services engineers (4.9%), building surveyors (4.5%) and landscape architects (3.3%). We also received responses from, among others, chartered surveyors, building engineers, civil engineers, facilities managers, structural engineers and contractors. This year's responses are from a more diverse range of professionals than previously.

During the three years we have been running this survey we have kept a core of questions that we have asked each year. This allows us to track changes and trends in the industry. Once again, though, we need to be careful. Because more and different people respond to the survey now, comparisons we make with previous surveys are best read as indicative rather than definitive. Nevertheless, some very clear trends emerge from the UK's largest BIM survey. So let's look at them.

CAD usage

Three years ago, when we started to explore attitudes to BIM, we wanted to understand use of the technology that many see as a precondition for it – 3D CAD. Indeed, we were concerned that people thought that BIM is 3D CAD. Well, we've established that the industry does not think 'BIM is just a synonym for 3D CAD drawings' – only 15% of respondents now agree with that statement. A majority see that BIM is not 'just about software' (less than a third agree that it is). BIM is not just geometric data.

Indeed, there is some suggestion that concentrating on just producing excellent 3D CAD models can hide poor construction information.

"All CAD drawings look great even if the content is nonsense"

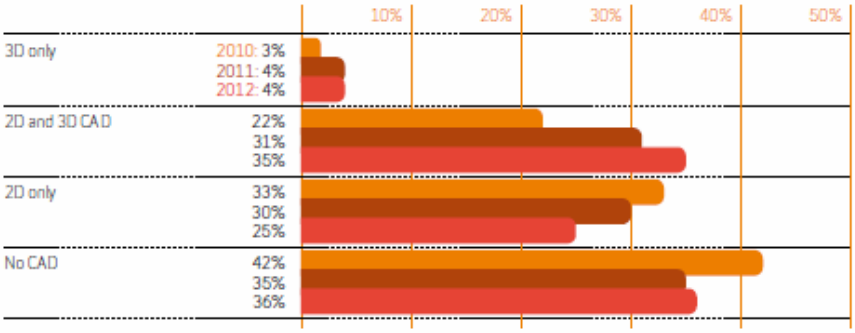
Nevertheless, the capabilities of CAD software – along with software independent formats and standards for information exchange – are a vital part of the BIM toolbox.

"BIM is an inevitable development from 3D CAD"

References

1. thenbs.com/pdfs/bimResearchReport_2011-03.pdf
2. thenbs.com/pdfs/NBS-NationalBIMReport12.pdf

CAD drawing: types done

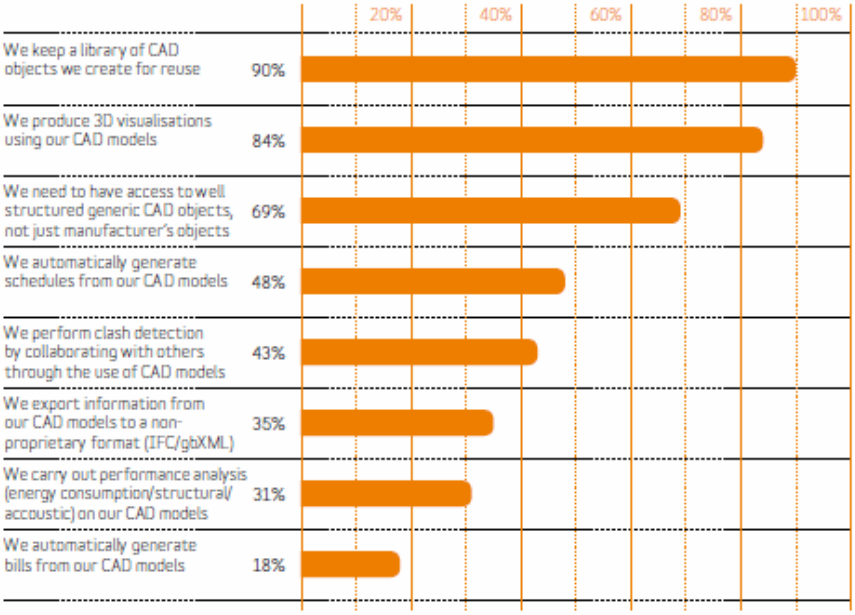


This year we have seen an increase in the numbers using 3D CAD – now nearly 40%, up from just over a third in 2011. This has come from a decrease in the number using only 2D CAD, and a corresponding increase in those using both 2D and 3D CAD. The numbers using only 3D CAD, and those not using CAD at all, have remained about the same, however.

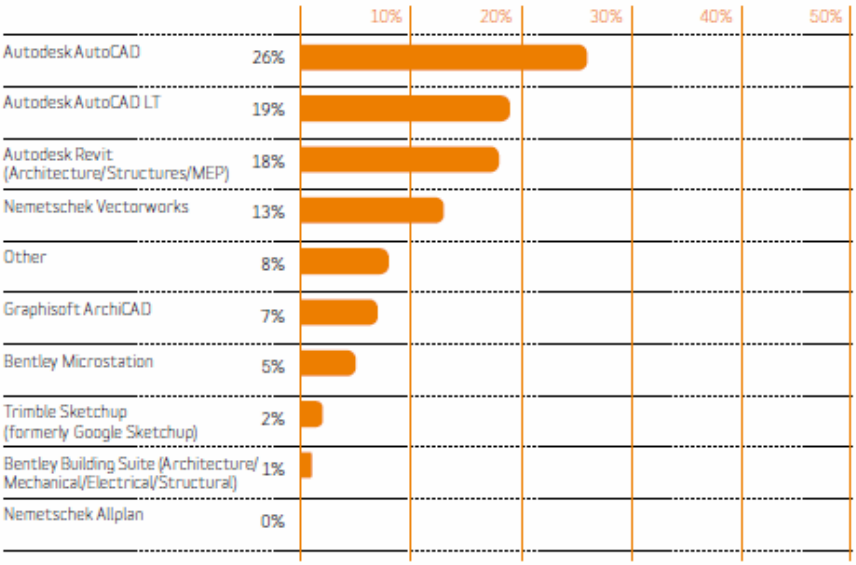
Respondents are continuing to use their CAD models for a range of purposes. Ninety per cent keep a library of CAD objects for later re-use, 84% produce 3D visualisations, 43% carry out clash detection. However, less than a third carry out performance analysis.

Around a third of people, 35%, tell us they export information to a non-proprietary format – central to higher levels of BIM where information is shared, irrespective of software used. We'll look at this in more detail later.

Where do you get the CAD objects your organisation uses?



When producing CAD drawings, which of the following tools do you mainly use?



We also asked which CAD package CAD users mainly use. We found that Autodesk, in its various flavours, accounted for around two thirds of the 'mainly used' packages, but there are significant other players in the market, notably Nemetschek, Graphisoft and Bentley.

Once again, whilst there is an appreciation that BIM is not 3D CAD, and 3D CAD is not BIM, purchasing, deploying and using 3D CAD is seen as a precondition for BIM.

"We are starting out by training staff to use 3D software"

"Making the shift from a traditional 2D workflow to a 3D BIM workflow is a big culture shift"

"We will take the BIM plunge, by getting our first seat of Revit and interfacing with NBS Create"

Whilst adoption of 3D CAD is increasing, when we looked at the free-text comments about CAD, we found a distinct unease among some, a feeling that perhaps the move to 3D CAD (and BIM) is driven by the commercial interest of software houses, rather than by a need to improve the construction process.

"The CAD companies are embracing the Government view with open arms, as it will massively boost their sales. There is a horrible smell of self interest/financial incentive here!"

"BIM is just another opportunity to fleece us again"

"It does feel like another huddle to keep the small practices out of the loop"

Later, when we look at people's attitudes to BIM, we'll see that this is a minority view and that most clearly see the benefits of BIM. But it is a view that is deeply held by some, particularly among smaller architectural practices. When thinking about the processes and tools that we, as an industry, are developing to support BIM we can't ignore this view if we want to be inclusive.

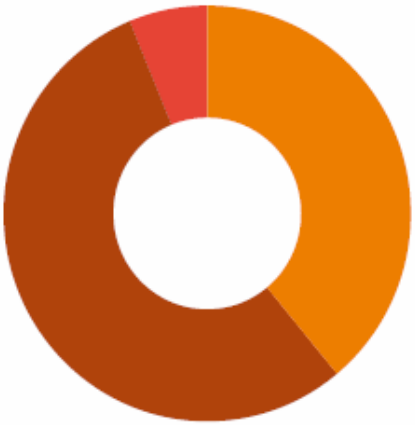
BIM usage and awareness

Strikingly, in this year's survey, only 6% had not heard of BIM. This may well reflect the amount of interest and publicity there is for BIM now as 85% agree 'you hear more and more about BIM these days'. But this isn't just talk. BIM adoption is also up, though less dramatically in 2011 to 2012 than from 2010 to 2011.

In 2010, we asked whether people had heard of BIM and whether, in three years' time, those who had heard of it would be using it. At the time, 43% were neither aware of nor using BIM.

Of those who were aware of BIM, just over 80% predicted that in the next three years they would be using BIM and 62% that they would be using it in one year's time. Well, forecasts are always dangerous things. Let's see how the BIM prediction has panned out.

We've gone from only 13% being both aware of and using BIM in 2010 to 39% in 2012. If we allow for adoption primarily by those who were aware of it three years ago, this is broadly in line with predictions. This is a dramatic adoption of new technology and working practice. We can reasonably expect further increases in BIM adoption as the Government's Construction Strategy becomes reality and as the construction industry inches out of recession.



Awareness and use of BIM

Aware and currently using BIM	39%
Just aware of BIM	54%
Neither aware nor using	6%

This view is supported by predictions about future adoption. We asked those who are aware of BIM (which now, unlike in 2010, is almost everyone) whether they will adopt BIM in the coming years. More people think they will; momentum continues to grow.

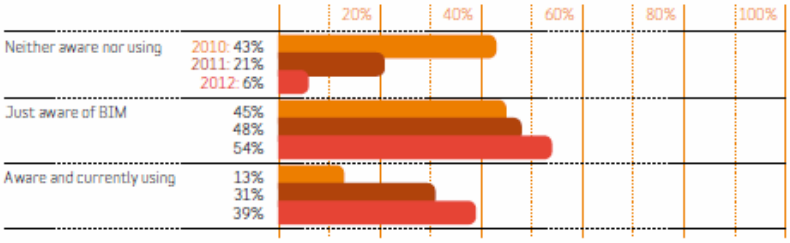
"I am looking forward to the next couple of years and how the industry is going to look as a BIM proficient industry"

That said, we found that people from larger organisations were more likely to agree that 'BIM is the future of project information'; over 80% of those from companies with more than 250 employees agreed, compared with 62% of those from practices with one or two people.

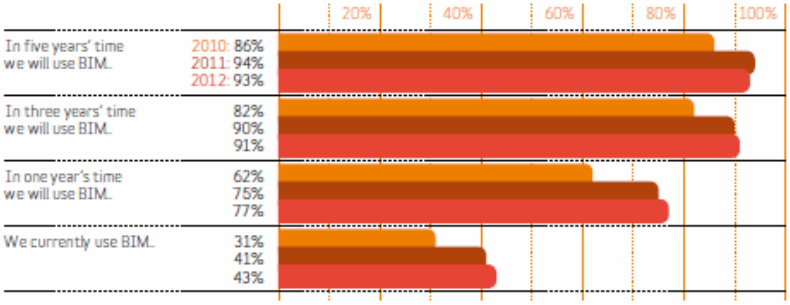
"The investment in software and training for implementing BIM is much easier for large organisations particularly in the current tough economic times"

If BIM is to be the new standard for project information, it must accommodate all practice sizes.

Awareness and use of BIM: comparison



Projected use of BIM among those aware of it



Attitudes towards BIM

We wanted to find out what people felt about BIM, and their attitudes towards it. You can see the main findings in the graph, but it's worth picking out a few points. People are rightly clear that the Government will start insisting on BIM for public sector work (80% agree) and the majority (51%) agree that the Government is on the right track with BIM. There is clarity on what BIM isn't. It isn't '3D CAD drawings', it's not 'all about software'. BIM doesn't 'lead to bland buildings', it isn't 'just for new build' and it doesn't stand in the way of 'bespoke design'.

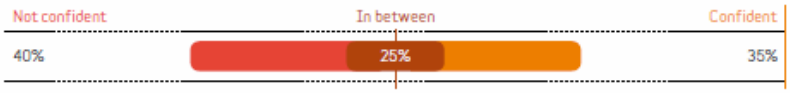
Slightly worryingly though, almost three quarters still feel that the industry is not clear enough on what BIM is; this number has remained about the same as last year and this has gone up by 10% from when we first asked.

"BIM seems to be very obscure and few of my colleagues or appointees in all the consultant fields seem to have any understanding of it"

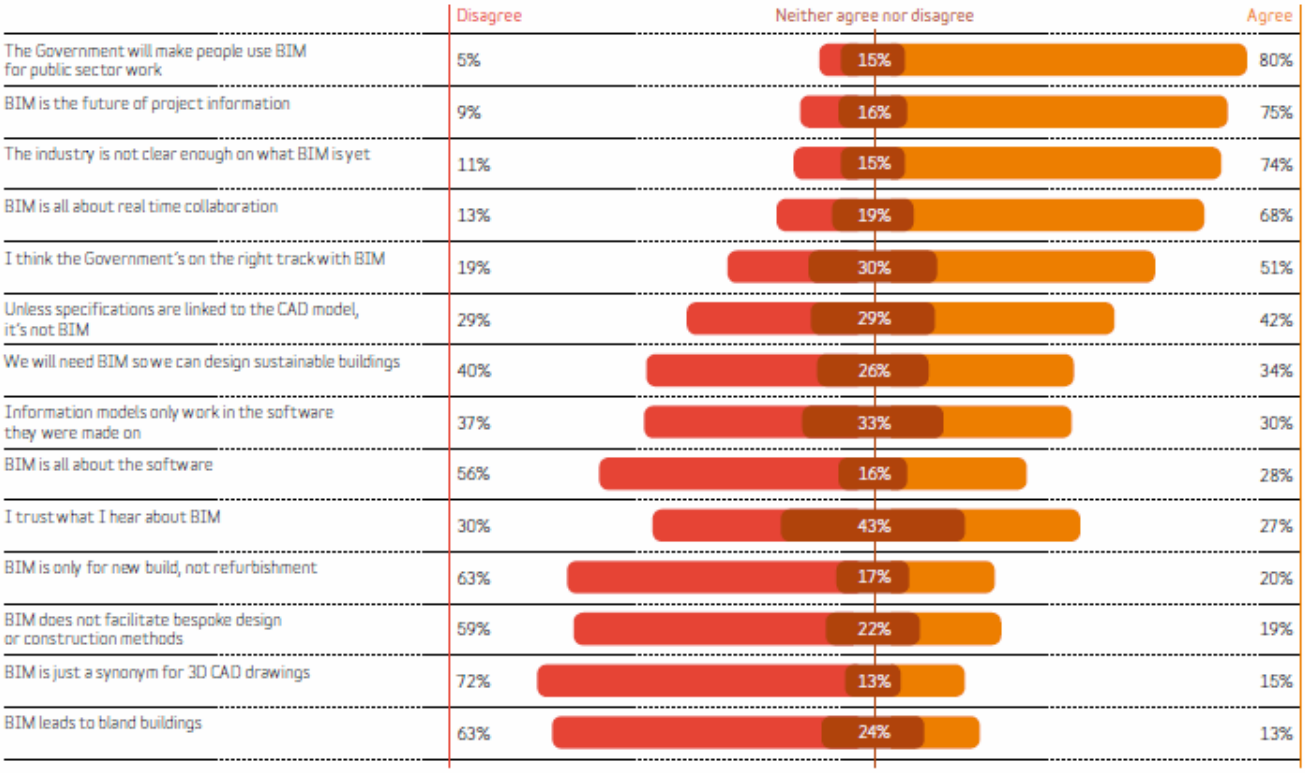
This may be related to a growing scepticism about available information. Only around a quarter of people (27%) agree that 'I trust what I hear about BIM'. Further, when we asked about how confident they are in their knowledge and skills in BIM, more people told us they were 'not confident' than 'confident'.

There's still work to be done.

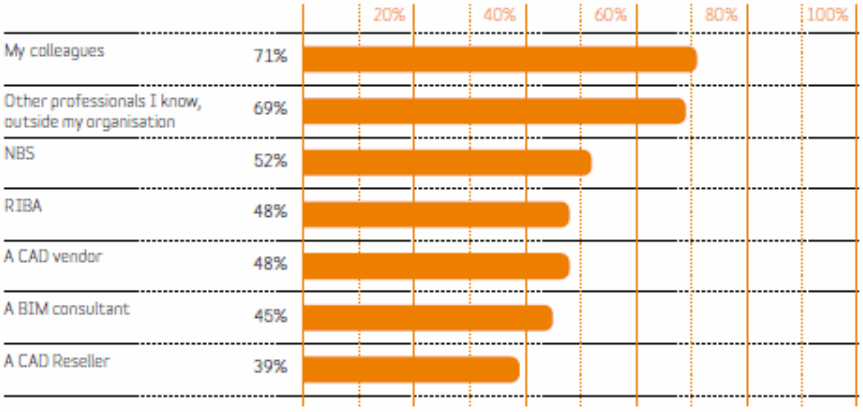
How confident are you in your knowledge and skills in BIM?



From your understanding of BIM, how strongly do you agree or disagree with the following statements?



Are you likely to turn to the following sources of information about BIM?



"It is clear that we will have to grow our knowledge of/use of BIM over the next year"

"More awareness presentations, publicity and training required"

"We have virtually no knowledge of what BIM entails or means to us operationally"

That said, there are available sources of BIM information that people told us they will turn to. Most people are likely to turn to fellow professionals, whether colleagues (91%) or other professionals (69%) in other organisations. NBS (52%) and the RIBA (48%) are also valued resources.

BIM and Government policy

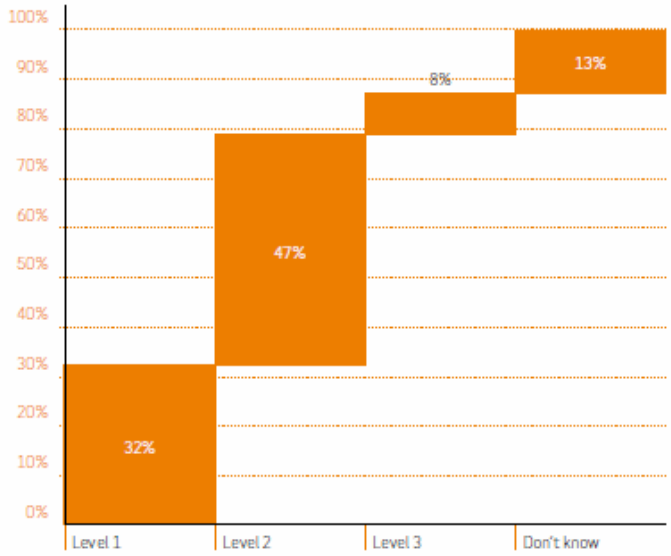
Government will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016.
Government Construction Strategy, May 2011[3]

"[Our organisation is] completely unaware that we will be required by Government to be at BIM Level 2 in three years' time. There seems to be no clear information available on this"

The Government set out its goal for BIM in its construction strategy. We've seen that in this regard, most people feel the Government is on the right track. Integral to this strategy is the movement from no BIM, to Level 1 then to Level 2 BIM[4]. We found that, of those aware of BIM, around a half were aware of these gradations of BIM maturity, around a half not.

Among those who were aware of the different levels, only 8% have reached Level 3, though almost a half tell us they have reached Level 2, the level the Government's construction strategy calls for by 2016.

What level would you say is the highest level your organisation has reached on a project?



The Government has described three levels of BIM. Are you aware of them?

Yes	51%
No	49%

References

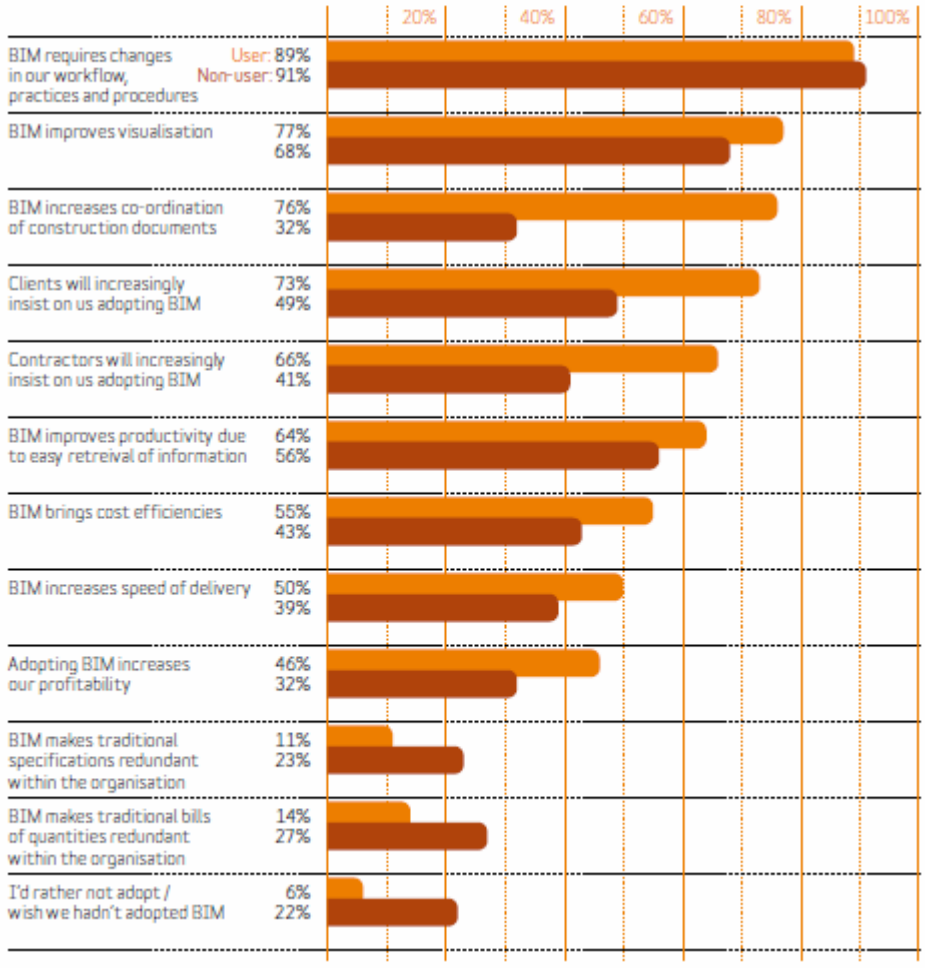
3. gov.uk/government/publications/government-construction-strategy
4. bimtaskgroup.org/wp-content/uploads/2012/03/BIS-BIM-strategy-Report.pdf

End note

As we saw last year, the use and awareness of BIM is increasing. However, the ongoing recession in the construction sector serves to hold back adoption. Some smaller practices, in particular, have reservations about BIM, software vendors and the Government strategy. There is still a lack of clarity about open file formats and how the information at the heart of BIM can be openly shared, independent of particular software.

But overall, the industry is positive about BIM. A majority think the Government is on the 'right track' with BIM. Those who are looking to BIM see its advantages, but tend to understate them. Those who have adopted BIM tell us that there are real benefits to be had, and they're greater than expectations. The anticipation of future adoption remains high. Delaying BIM implementation may reduce expenditure – but the risk is an even greater reduction in future income.

Attitudes towards BIM:
A comparison of those who use it, and those who don't



PRILOGA 6: Rezultati NBS ankete 2014

NBS National BIM Report 2014

BIM Survey: Summary of findings

Adrian Malleson
Head of Research, Analysis and Forecasting, NBS

"BIM is already the future - and it is here today."

Introduction

This is the fourth NBS National BIM report. We first carried out BIM research in 2010. The results suggest we are at tipping point. BIM is moving from being a niche practice to a process adopted, for at least some projects, by a majority.

This is significant. Since we first ran the survey, we have seen the UK slowly emerge from the worst post-war recession, the publication of the UK construction strategy, and the rapid development of tools to support the BIM process.

The Government construction strategy sets out a range of ambitious targets:

- 33% reduction in the initial cost of construction and the whole life cost of built assets.
- 50% reduction in the overall time, from inception to completion, for new-build and refurbished assets.
- 50% reduction in greenhouse gas emissions in the built environment.
- 50% reduction in the trade gap between total exports and total imports for construction products and materials.

Improvements in productivity like these come from innovation. Much of the innovation we have seen over the last few years has come through advances in how we collect, aggregate and repurpose data so that we can both do new things, and do old things better. BIM is an example of this. An innovative construction industry is one ready to make up the ground lost in the recession. By mandating the use of BIM in publicly-funded projects by 2016, the Government shows that it sees this. BIM is a cornerstone of its strategy.

This report presents the findings of our fourth survey. We look at BIM adoption and professionals' attitudes to it. We look at how people have found the processes of adopting BIM, and how that compares to the attitudes of those who have yet to do so. This year, we also spend a little time exploring the views of smaller practices.

A clear picture emerges. BIM awareness is now nearly universal. BIM adoption is growing year on year and, for the first time, the majority of those who took part in the survey have used BIM on at least one project in the last year. The expectation is that within three to five years, BIM use will be almost completely universal.

Professionals are positive about BIM and feel that the Government is on the right track. Confidence in BIM knowledge and skills is increasing, though still has a way to go. A minority remains unconvinced about BIM.

There is insufficient clarity about what BIM is, although this is improving, and there is much shared understanding. There is agreement that BIM is not just software. BIM is not just CAD, or geometric data. BIM is a collaboratively generated and maintained, data rich, information source for the life of the design process and beyond. In the future, we will see the greatest value derived from BIM in the use and maintenance of buildings.

We carried out the survey in late 2013 and early 2014. Once again, we had an excellent response, with over 1,000 construction professionals from a range of disciplines completing the survey. This makes it the most comprehensive, cross-discipline assessment of BIM in the UK.

The report gives us a description of where BIM is now. It also describes the changes that have been happening over the last four years. We can track these changes because the survey includes a set of core questions that we ask each year.

As in previous years, we are grateful to those of you who took the time to complete the survey – without the responses there could, of course, be no report. The comments people left in the text boxes gave us vivid illustrations of the individual views and experiences that lie behind the percentages. The BIM journey isn't a single path, and every practice has its own story to tell. We've used the comments to breathe a little life into the raw statistical findings.

We're also grateful to the many professional bodies that publicised the survey to their membership. This kind of assistance is vital to providing a rounded set of findings where all professions have a chance to put forward their views – particularly as collaboration is at the heart of BIM.

Let us now turn to the detailed findings.

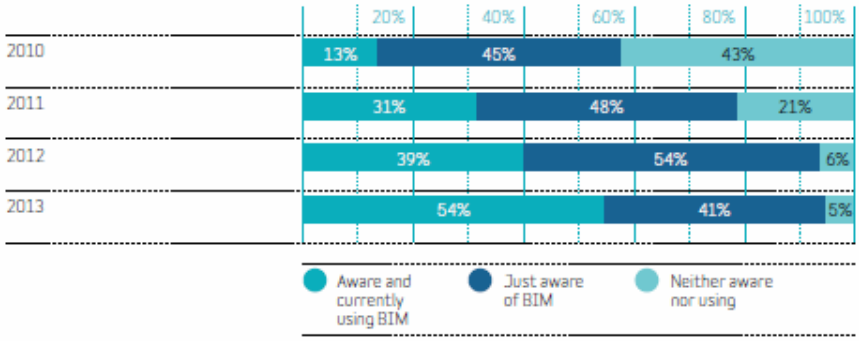
BIM usage and awareness

Awareness of BIM is now nearly universal. It has risen from 58% in 2010 to 95% in 2013. Now only 5% of participants are unaware of BIM. Contrast this with 2010, when 43% of respondents had not heard of BIM. This rise may be because the Government has mandated use of BIM for publicly-funded projects by 2016, less than two years away. Awareness has increased, and so too has adoption. In 2010 BIM was very much a specialism of a small number – 13% – of practices. Now the majority of practices have adopted BIM. In the last year, 54% had used BIM on at least one project. That's 15% more than last year.

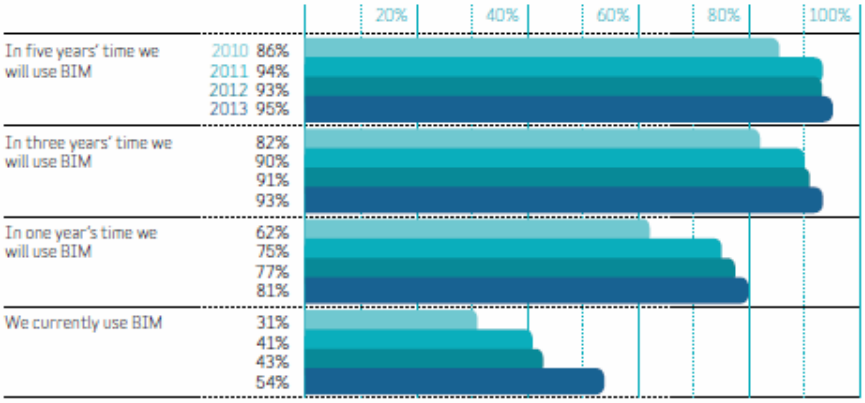
We went on to ask those (and only those) who were aware of BIM about their current and future BIM usage. We excluded those who were unaware of BIM, or unsure of their answer, from the percentages. Just over 93% predicted that in the next three years (i.e. by 2016) they would be using BIM, and 81% that they would be using it in one year's time. The Government's BIM mandate for 2016 may be a spur to BIM adoption.

The data from the last four years suggests that being aware of BIM is a stage on the way to BIM adoption. If intentions become reality, some degree of BIM use within practices will become the norm. Looking at the data, it's striking that the adoption rate now is more than that projected by those who were aware of BIM in 2010. The Government's target is not looking far-fetched.

BIM Usage and Awareness over time



Projected use of BIM among those aware of it



Percentages exclude those unaware of BIM or unsure of their answer

Attitudes towards BIM

We wanted to find out what people felt about BIM: their attitudes towards it. In the past, we have found that most (though not all) people are positive about BIM. This continues.

As last year, around four fifths of people tell us that BIM is the 'future of project information' and that 'the Government will make people use BIM for public sector work'. Forty per cent see that a Building Information Model needs links between geometric and specification information.

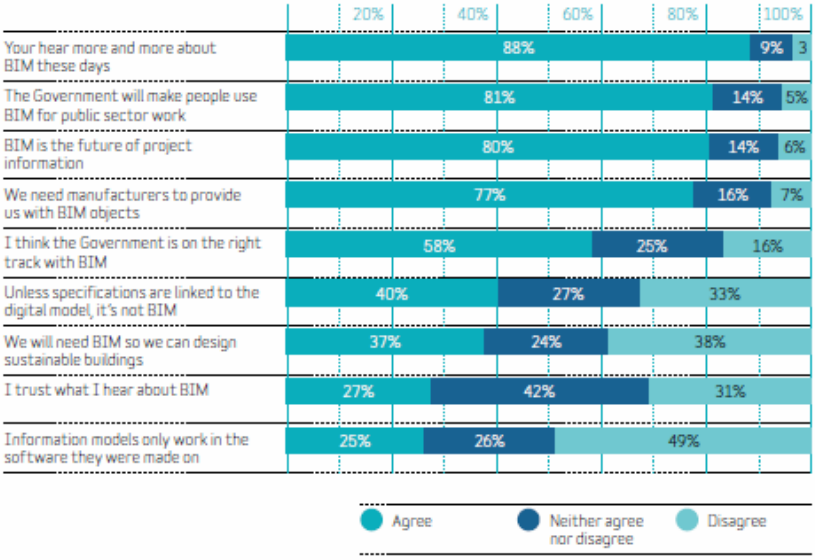
There is no evidence that the majority of people resent or want to resist the Government's BIM strategy. Fifty eight per cent agree that the Government is 'on the right track with BIM', whilst only 16% disagree with that statement.

As designers move from BIM awareness to BIM implementation, they are starting to turn to manufacturers for details of their products in a BIM-ready format. More than three-quarters tell us that they 'need manufacturers to provide us with BIM objects'.

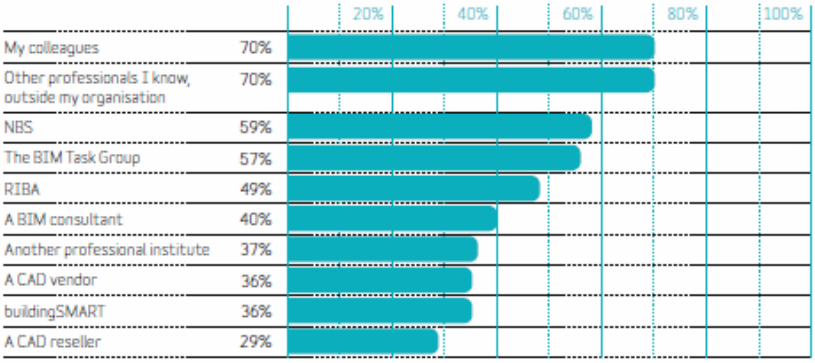
There is a level of scepticism about the information available for BIM. Only a third tells us that they 'trust what they hear about BIM'. This year we wanted to dig a little deeper here and find out, with such levels of distrust, where people turn for BIM information. So we asked.

Fellow professionals, both within (70%) and outside (70%) organisations, are the preferred source of information. Beyond that, people turn to NBS (59%), the BIM Task Group (57%), RIBA (49%), and BIM consultants (40%). Less than a third turn to a CAD reseller.

How strongly do you agree or disagree with the following statements?



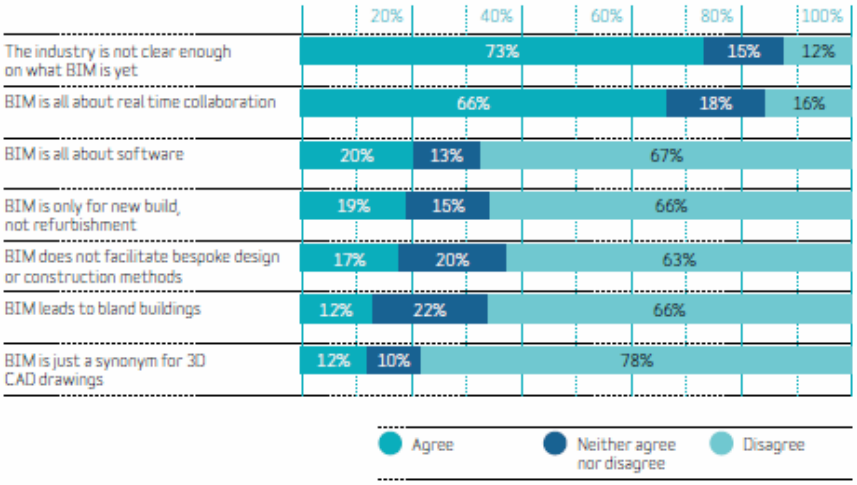
Which of the following sources are you likely to turn to for information about BIM?



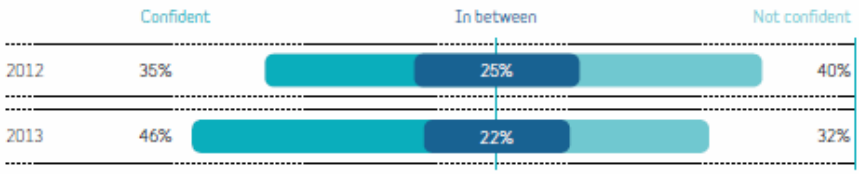
We also wanted to get an appreciation of what BIM is and what it's not. There is some clarity. Respondents were clear that BIM is about real-time collaboration, and that it doesn't just mean CAD drawings: it's not all about software. There remains a strong feeling, though, that the industry is not clear enough on what BIM is yet, with almost three-quarters (only slightly less than last year) agreeing with the statement.

What to make of this? An extreme interpretation would be that people just have no idea what BIM is. But the consistency in responses to other questions suggests that's not it. Rather, there is a need for BIM education among actual and potential users, as the graph below suggests. A third of people describe themselves as 'not confident' in BIM knowledge and skills. But the picture is improving: we've gone from 35% who were confident in 2012 to 46% in 2013.

From your understanding of BIM, how strongly do you agree or disagree with the following statements?



How confident are you in your knowledge and skills in BIM?



BIM maturity

We wanted to explore how use and awareness of BIM has developed among respondents. We can see that there is a broad awareness of the levels of BIM. Awareness has grown from 51% in 2012 to 73% in 2013.

Among those who were aware of the different levels, a majority have reached at least Level 2 and 7% tell us they have reached Level 3. That still leaves 42% who have yet to reach the level of BIM maturity required for publicly-funded work in 2016.

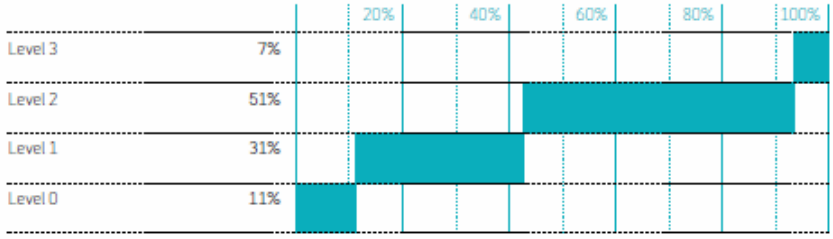
For collaboration to be successful, collaborating parties need to use agreed standards. Only 24% agreed that the current level of standardisation is right, suggesting that the construction industry needs to implement a greater degree of standardisation for BIM adoption to be successful.

The Government has described there being different levels of BIM. Are you aware of these different levels?

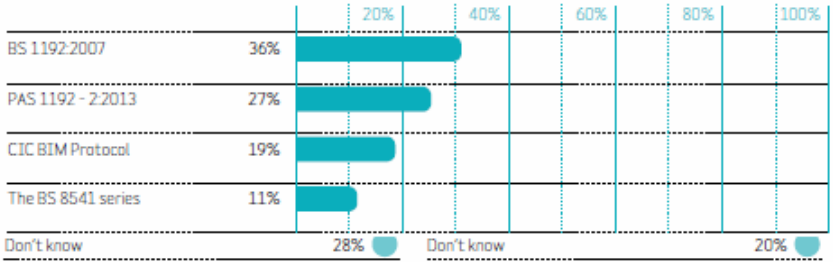
2012	
Yes	51%
No	49%

2013	
Yes	73%
No	27%

What level would you say is the highest level your organisation has reached on a project?



Which of the following standards/publications does your organisation use?



With 36% using BS 1192:2007 and 27% using PAS 1192 - 2:2013, we can see that a significant number of respondents use standardised processes for the ownership, review and sign-off of information, before that information is more widely shared. This is crucial for larger projects and practices where information goes across and beyond the design team.

We also looked at how widely respondents used Industry Foundation Classes (IFC) and Construction Operations Building Information Exchange (COBie). As BIM maturity and collaboration increases, the need grows for open, sharable, non-vendor-specific data formats.

IFC, as a platform-neutral, open file format, allows models to be shared among the design team, irrespective of software choices. We can see that 45% now use IFC (an increase of 6% from last year). Awareness of this format is growing too, with those who 'don't know' decreasing from 30% to 21%.

COBie allows the design team to use a Building Information Model to embed and then deliver the information that supports the use and maintenance of a building. It is perhaps here more than anywhere that cost savings for the client can be realised.

Only a minority use COBie, 23%, but the number is growing: up from 15% in 2012. Awareness of COBie is also growing, with the number who 'don't know' falling from 28% to 20%. We expect the numbers generating COBie output to continue to grow over the coming years.

Do you use IFC on your projects?

2012

Yes	39%
No	31%
Don't know	30%

2013

Yes	45%
No	34%
Don't know	21%

Do you use COBie output on your projects?

2012

Yes	15%
No	56%
Don't know	28%

2013

Yes	23%
No	57%
Don't know	20%

BIM and small practices

In last year's report, we noted:

"If BIM is to be the new standard for project information, it must accommodate all practice sizes."

Towards the end of this year's survey, we asked if people had any other comments they'd like to make. Many of the comments were about small practices' experiences with BIM.

Some were overtly negative about BIM:

"BIM is yet another discrimination against small independent practices in the built environment sector."

Some felt that BIM wasn't applicable to their work or practice:

"For small practitioners on tight fees BIM is little or no use."

"BIM is inappropriate for the nature and scale of private projects that are the mainstay of my work and income."

Others were concerned that information models should exist independently from any particular software vendor:

"I'm a bit uneasy by the degree to which BIM is in the hands of commercial outfits. I feel a truly collaborative BIM needs to be based around open solutions."

Others were positive about BIM:

"We needed something to uplift the construction industry, store and manage information which was unthinkable previously. BIM is not easy, but it will make your life a lot easier."

"BIM needs EVERYONE onboard."

One mentioned:

"I am curious to see the results of this survey among smaller firms."

We looked at the responses that people gave based on the number of people in their organisation. We found that there were significant differences between larger and smaller organisations.

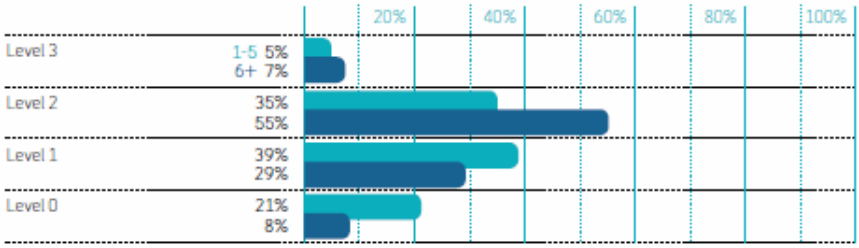
Firstly, smaller practices are less likely to have adopted BIM. For organisations with six people or more, 61% have used BIM in the previous year. For those with fewer, the figure is just over a third, 35%. To put it another way, BIM adoption among smaller organisations is at the level we saw in the wider industry two years ago.

BIM usage and awareness, by number of people in organisation

1 - 5	
Aware and currently using BIM	35%
Just aware of BIM	58%
Neither aware nor using BIM	7%

6 or more	
Aware and currently using BIM	61%
Just aware of BIM	34%
Neither aware nor using BIM	5%

Highest level of BIM used by organisation, by number of people in organisation



Even among those who have adopted BIM, use of BIM is less rich than in larger organisations. For example, 62% of those in larger organisations have used at least Level 2 BIM, whilst in smaller organisations that figure drops to 40%. We see a similar picture for use of COBie (33% for larger organisations, and 13% for smaller) and IFC (61% for larger organisations, and 41% for smaller).

We can also see that smaller organisations are less confident in their BIM skills. Whilst half of those working in larger organisations describe themselves as 'confident' in their knowledge and skills in BIM, this figure drops to a third for smaller organisations.

So we can see a relative lack of confidence among smaller organisations. What else stands in the way of BIM adoption?

The graph below right gives the top five barriers to BIM adoption among smaller organisations.

There is some commonality. For both smaller and larger organisations, cost is a barrier, with 67% of smaller organisations and 64% of larger ones citing it. A lack of in-house expertise is a barrier to both groups as well, with over three-quarters of larger organisations mentioning it and 62% of smaller ones.

For smaller organisations, client demand is the highest barrier to BIM adoption. Whilst the Government enforces BIM for publicly-funded work, clients of smaller organisations don't often make similar demands. Sixty three percent of small organisations tell us that the projects they work on are 'too small' to warrant BIM and 71% that BIM is 'not relevant to the projects we work on' - perhaps because the level of complexity just isn't there to warrant BIM.

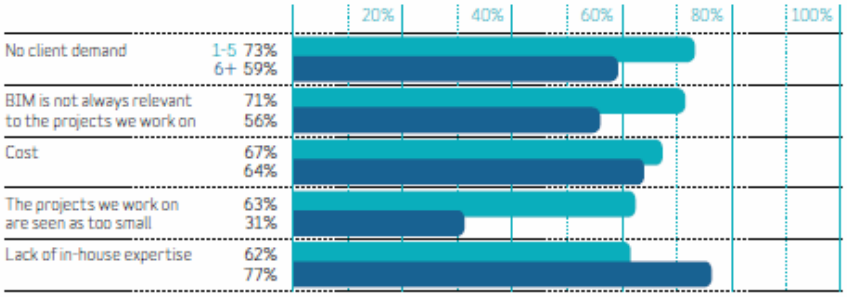
There is a risk here that we can describe in two ways: either that the Government, through its BIM strategy, is excluding smaller organisations from a significant source of revenue (publicly-funded work), or that smaller organisations need to adopt BIM to prepare themselves for 2016 (as many are already doing).

In any case, if BIM is to become a tool for all designers, there is work to be done, not only by smaller practices but also by the wider industry.

How confident are you in your knowledge and skills in BIM? By number of people in organisation

1 - 5		6 or more	
Confident	35%	Confident	50%
In between	24%	In between	21%
Not confident	41%	Not confident	29%

Barriers to BIM adoption? By number of people in organisation



Software use

Since we started running the survey in 2010, Autodesk AutoCAD has consistently been the most used software package for building design in the UK. This year it is Autodesk Revit.

This is consistent with increasing numbers producing fuller information models. Designers are more often using intelligent 3D model-based design tools to create their drawings. But Revit is not the only option: other modelling tools such as Graphisoft ArchiCAD and Nemetschek Vectorworks continue to have a loyal user base.

As designers adopt more advanced modelling tools, the need grows for a broad range of objects with which to populate the models. Through the NBS National BIM Library, NBS provides a service to help with this.

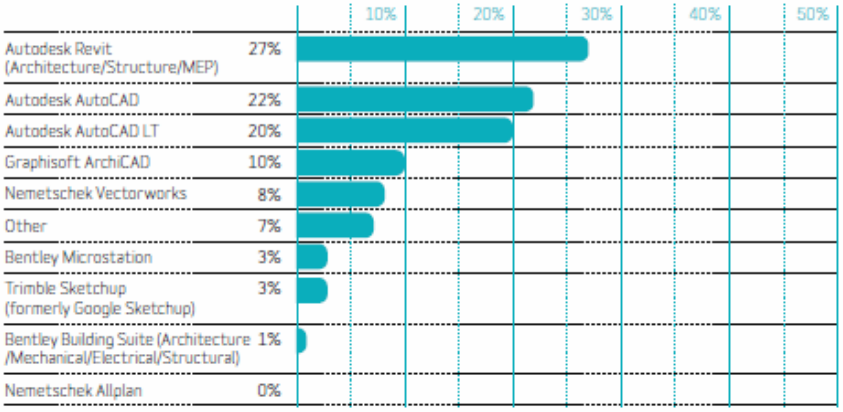
The most popular way of getting BIM objects is to create them in-house and then re-use them (77%), followed by creating them as needed (68%). There must be risks here, as information embedded within a re-used object created in-house can become outdated or obsolete. Creating models as needed leads to much duplicated work across the industry. We feel that a central, free-to-use resource of information-rich BIM objects is better. So it's pleasing to us that nearly a half (49%) turn to the NBS National BIM Library to get the up-to-date objects that they need, when they need them.

BIM experience

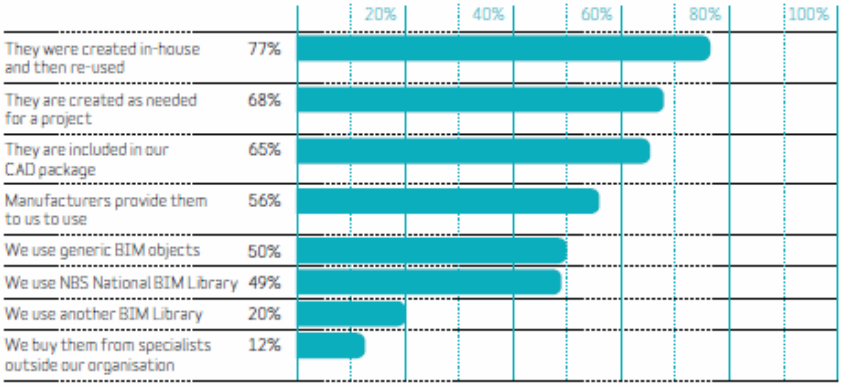
We asked those who were yet to adopt BIM what stood in the way of their doing so. The signs are that the economy, both generally and for the construction sector, is improving. This is reflected in a drop in those telling us they 'need to get through the downturn' before looking at BIM – from 47% to 37%. Cost remains a significant barrier though, with 60% telling us BIM is 'too expensive to consider'. But the majority will need to adopt BIM; 59% tell us that if they don't adopt BIM they'll 'get left behind'.

We looked at the views of those who have adopted BIM and compared them with those who were aware of BIM but who had not yet started using it. This allows us to compare expectation with experience. The experience is better than the expectation. Those who have adopted BIM are more likely to be positive about it than those who have yet to.

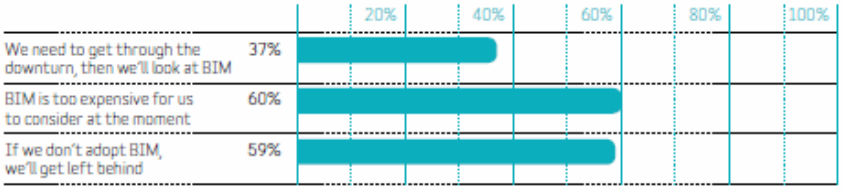
When producing drawings, which of the following tools do you mainly use?



Where do you get the BIM objects your organisation uses?



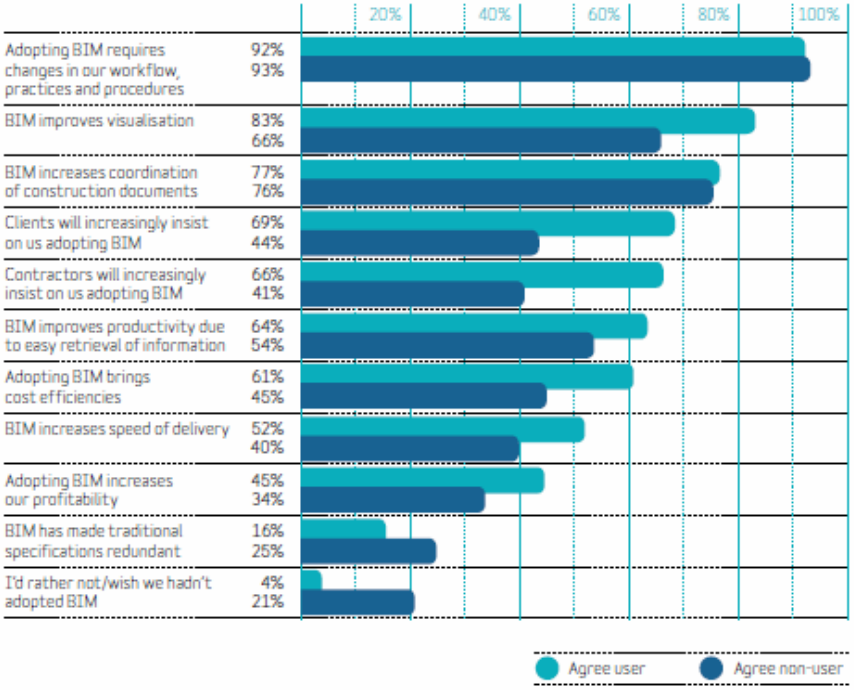
Attitudes of non-users



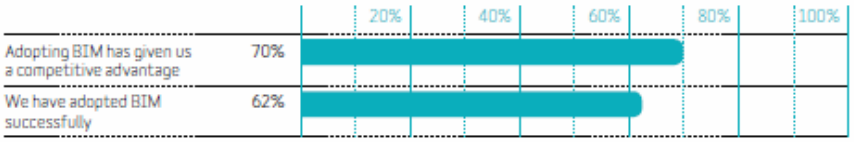
Only 4% wished that they hadn't adopted BIM, whilst 21% of non-users would rather not adopt BIM. More importantly perhaps, 61% of users found that BIM brought cost efficiencies, 52% that it increased the speed of delivery and 45% agreed that it increased profitability (16% disagreed; the remainder, 39%, were neutral). Those who have adopted BIM predict that both clients and contractors will insist on the adoption of BIM. With unremitting pressure on architects' and others' professional fees, it looks as if BIM may offer a way to getting more work, and making that work more profitable.

For those who have adopted BIM, the data is unequivocal. The experience of those who have adopted BIM shows us that the process, whilst not easy, is worthwhile. It delivers a competitive advantage.

Attitudes towards BIM: A comparison of those who use it and those who don't



Attitudes of users



End note

In the UK, through BIM, we are at the forefront of a significant change in how buildings are conceived, designed, built and maintained. This change has the potential to bring improved efficiencies and profitability to the construction sector, and deliver better buildings to clients.

There remain significant difficulties though. Investment of time and capital is required. Smaller practices, in particular, see the BIM journey as a difficult one to undertake. The industry lacks clarity. Some see BIM as exclusive to larger businesses. The industry has a responsibility to be inclusive through open, software-neutral standards.

Looking through the responses to the survey, a clear picture is drawn. Overall, the industry is positive about BIM and the real benefits it can bring. The Government mandate for BIM is welcomed. We are moving from a phase where early adopters led the way, to one of BIM becoming the norm. There is a wide appreciation of the benefits that BIM will bring, and those who have adopted BIM are more positive about it than those who are yet to. The projections of BIM adoption (and previous projections have been realised) tell us that the UK can be world leaders in BIM.

Adopting BIM may be less risky and less cost-effective than not doing so.

PRILOGA 7: Rezultati NBS ankete 2015

NBS National BIM Report 2015

BIM Survey: Summary of findings

Adrian Malleson
Head of Research, Analysis and Forecasting, NBS

Introduction

NBS first monitored the use and adoption of BIM in 2010. At the time, BIM was very much a minority process, which less than 15% of the design community engaged in. Fifty eight percent were aware of it, but that left a significant number who were unaware of BIM. We have moved on.

Discussion about BIM has proliferated, and awareness of it is now nearly universal. Many more people are using BIM than were in 2010. The industry, including NBS, is doing significant work in developing the tools, information and standards that we need to make BIM demonstrably deliver value to designers and clients alike.

The UK Government is committed to BIM. In its construction strategy document there is the clear statement that:

"Government will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016."

But time is short. 2016 is nearly upon us. As an industry, we have limited time to adopt BIM (in the sense the Government requires) for centrally-procured government projects.

This report looks at some of the issues that this raises, and how the market is responding. We explore BIM adoption and usage, attitudes towards BIM and its place in the construction timeline, as well as the industry's evaluation of the Government's approach. Because the survey has been running for a number of years now, and contains a number of unchanging questions, we can look at changes over time.

As in previous years, we are grateful to those of you who took the time to complete the survey – without the responses there could, of course, be no report. The free text comments can be especially enlightening and give clear illustrations of the real-world successes and frustrations with the BIM process. We have used these to illustrate specific points.

We are thankful too to the professional organisations that have publicised the survey among their membership. This assistance allows us to draw on the views of a range of design and construction professionals to give a more rounded view of BIM adoption in the UK.

Given how close 2016 is now, let us first look at the industry's assessment of the Government's approach to BIM.

The UK Government and BIM

We asked people what they thought about the UK Government and BIM. We wanted to understand whether people believed that the Government would mandate BIM and whether, broadly speaking, the Government was on the 'right track' here. We found that over four fifths (81%) of people believed that the Government would make people use BIM, in one way or another, for public sector work. More specifically, we found that 70% felt that the Government would mandate BIM in the way specified in the construction strategy document, namely 3D collaborative BIM.

We also see that a majority believe the Government is on the 'right track' with BIM. Part of the Government's approach is to establish the UK as a world leader in BIM, having identified BIM as a means of creating global opportunities for the UK construction sector. Those who responded to the survey were a little more circumspect. More disagree that the UK is a global leader than those who agree; most neither agree nor disagree.

For the UK Government there are four demanding targets for the construction sector, described in the 2025 Construction Strategy:

- 33% reduction in the initial cost of construction and the whole-life cost of built assets.
- 50% reduction in the overall time, from inception to completion, for new-build and refurbished assets.
- 50% reduction in greenhouse gas emissions in the built environment.
- 50% reduction in the trade gap between total exports and total imports for construction products and materials.

The requirement for BIM adoption is there because the Government sees it as integral to meeting these targets. We wanted to test whether people felt that it was true that BIM would help us to achieve them.

Of those who had an opinion (and not all did) there was, overall, a belief that BIM would help. This was strongest for 'reduction in building costs' (both capital and whole-life), with 63% feeling that BIM would help bring a reduction. A majority (54%) also felt that BIM would help to reduce the time it would take to move from the inception to the completion of buildings.

When it comes to a reduction in greenhouse gas emissions and a reduction in the trade gap of construction products, the feeling was less strong. Whilst in both cases very few feel that BIM will hinder efforts, there is a less strong feeling that BIM will help. Forty one percent think that BIM will help reduce carbon emissions, and 28% that it will reduce our construction product trade gap. But it's only a very small number (3% and 4%) who feel that BIM will hinder here.

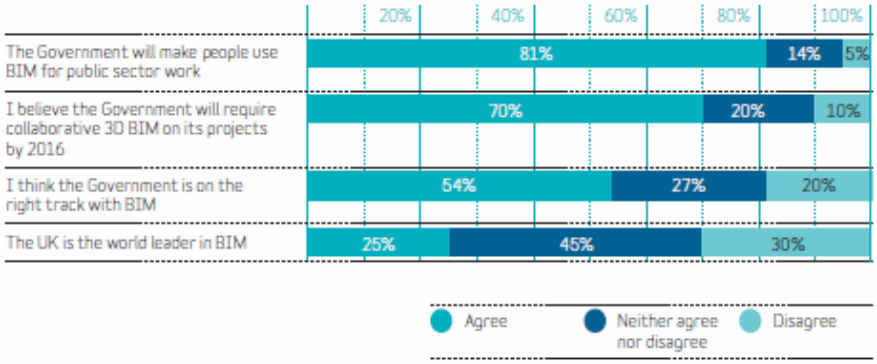
Overall then, the assessment of the design community is that the Government is right to prioritise BIM, and they find the Government's commitment to BIM credible. Some want the Government to go further:

"Further extension of the Government's targets into areas such as social housing."

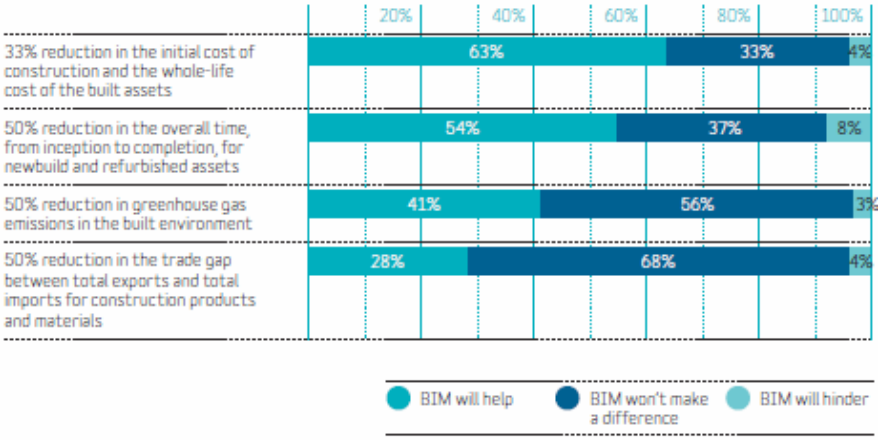
BIM is set to help reduce the whole-life cost of buildings for government-funded building, and reduce the time to completion. The hope is that success in government-funded projects will lead to wider adoption in the private sector:

"The next natural step after 2016 is for BIM to trickle down to private enterprise."

From your understanding of BIM, how strongly do you agree or disagree with the following statements?



The Government's UK Construction Strategy for 2025 has set four targets. What role will BIM have in achieving them?



BIM usage and awareness

Current use

Until this year, the story of BIM usage and awareness has been straightforward. Year on year, the total usage and awareness has increased, as has the proportion of those using BIM.

This year the story has become more nuanced. Last year we saw a majority telling us they had adopted BIM on at least one project they had worked on in the preceding twelve months. This year we have seen no growth in BIM usage. Indeed, we see a very small drop (6%, from 54% to 48%).

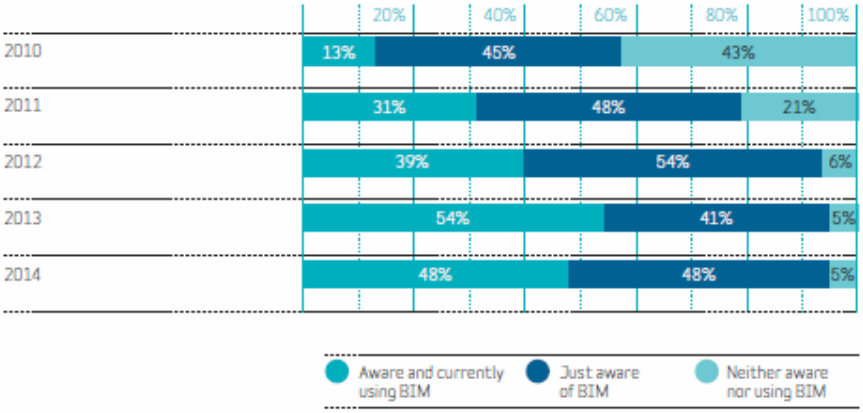
Thus at first sight these findings are puzzling. Have we reached BIM's peak? We would suggest not: it's more of a plateau before the 2016 deadline for BIM adoption.

A few things may be going on. Firstly, evidence from the market (see the RIBA Future Trends Survey and ONS construction output data) suggests that workloads are increasing, as we finally move firmly away from recession. As workloads increase, time to invest in new processes and software decreases.

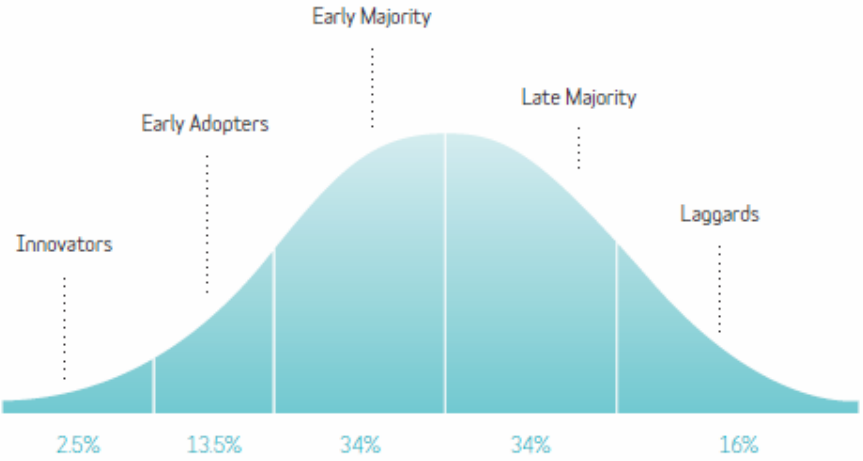
Secondly, we may understand this in terms of Everett Rogers' standard adoption curve. This follows a normal distribution curve where the 'Innovators', 'Early Adopters' and 'Early Majority' rapidly move to a new innovative technology to a point where its use is found within half of the population. Adoption then slows for a while as the 'Late Majority' join, followed by the 'Laggards'. Whilst not always finding these terms fitting, we suspect that we are at the midpoint of the adoption curve, and will see more rapid adoption in the coming years, as and when BIM demonstrates its real-world value.

Finally, detailed analysis of the data suggests that there has been a small, but statistically significant, shift in those who have taken part in the survey, particularly by the design software used. If we adjust the analysis to compensate for this, we do see an increase in BIM adoption.

BIM awareness and usage



Innovation Adoption Lifecycle



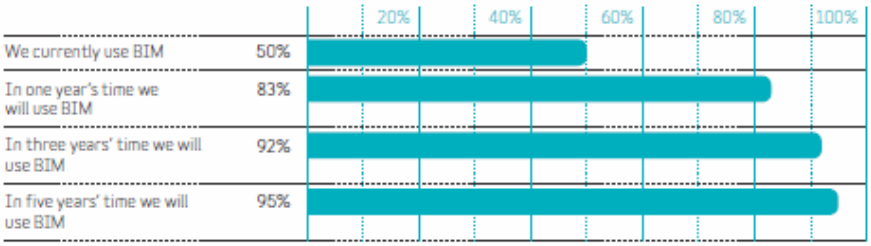
'Diffusion of Innovation' – Everett Rogers
http://sphweb.bumc.bu.edu/otlt/MPH-Modules/SB/SB721-Models/SB721-Models4.html

Future use

"BIM is the future and should be embraced."

We also asked those who are aware of BIM whether they will adopt it in the coming years. On this measure, we see a continued expectation that BIM will become the 'de facto' standard for the design process – and will do so within three years. Ninety two percent expect to be using BIM within three years, and 95% within five.

How would you describe your organisation's future use of BIM?



BIM maturity

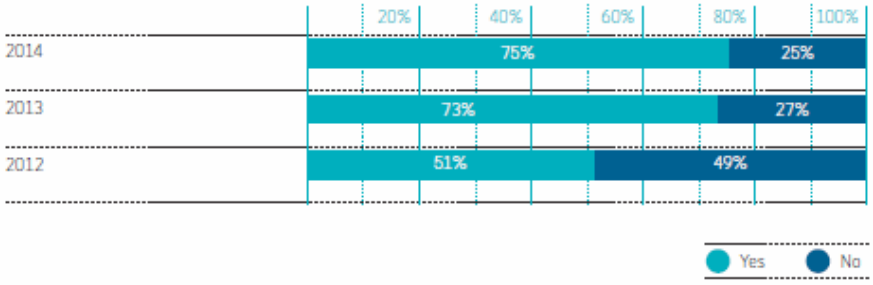
BIM levels

We have seen that the Government requires Level 2 BIM by 2016. For this to happen, we need general awareness of the different 'levels' of BIM, and then for practices to reach the required level, Level 2. (These levels are described in the Richards and Bew model that you can access through the BIM Task Group).

Three quarters were aware of the different levels of BIM.

This is a very slight increase in the level of awareness we reported on last year, but it has only increased by a couple of percentage points. There is still work to do in terms of educating the market about these levels, and what they mean in practice.

The Government has described there being different levels of BIM. Are you aware of these different levels?



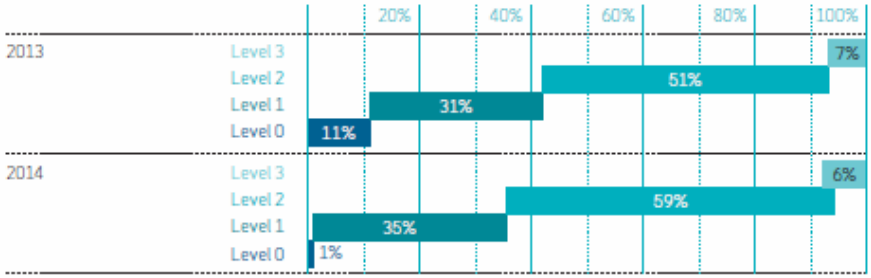
For those who had adopted BIM we asked what was the highest level of BIM they had achieved in the previous year.

We can see that the proportion of Level 0 projects has significantly dropped away, to just 1%. For over a third of BIM practitioners, Level 1 is the highest level they have reached.

The proportion of practices reaching Level 2 has grown to 59%, up from 51%. This demonstrates an increase in the number ready to meet the Government's requirements.

Level 3 remains a topic of occasionally intense discussion, with agreement that at best it is poorly defined. Many take the view that it's impossible to achieve, given the current tools and standards that we currently have. Thus the very slight decline in those telling us that they have reached Level 3 is perhaps best understood as an increase in awareness that 'Level 3' is unclear, rather than a drop in BIM maturity *per se*.

What would you say is the highest BIM level your organisation has reached on a project?



Use of standards

"All construction information should be based upon open standards."

The adoption and use of shared standards is integral to BIM. They are the substrate for collaboration. Thus we wanted to understand which standards are being used, and by what proportion of the industry.

For BIM to be successful, models (and objects) must contain information that is verifiably of a shared, open standard. In the adoption of BS 1192:2007 and 34% using PAS 1192-2:2013, for example, we see a broad - but not universal - adoption and use of standardised processes for the ownership, review and sign-off of information.

We can also see that some of the newer standards (or descriptions of ways of working) have gained rapid traction.

The RIBA Plan of Work 2013, which organises the process of briefing, designing, constructing, operating and using buildings, is being used by 71% of respondents. The online toolbox, designed to support it, is being used by nearly a quarter. The NBS BIM object standard, released in September 2014, is now being used by 18%. This willingness to adopt and adapt to new standards is promising. The standards that describe (and prescribe) BIM are beginning to be adopted as they become available. However, greater adoption of them will be required in the future.

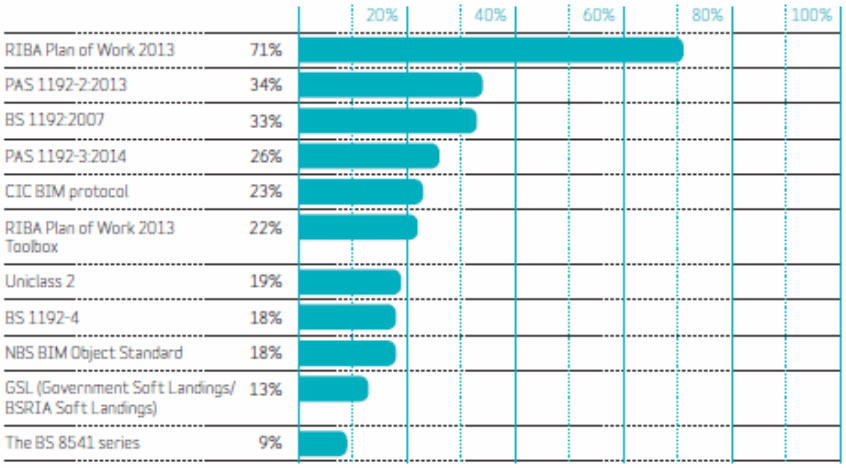
BIM practice

"BIM is not about software, but a more collaborative method of working."

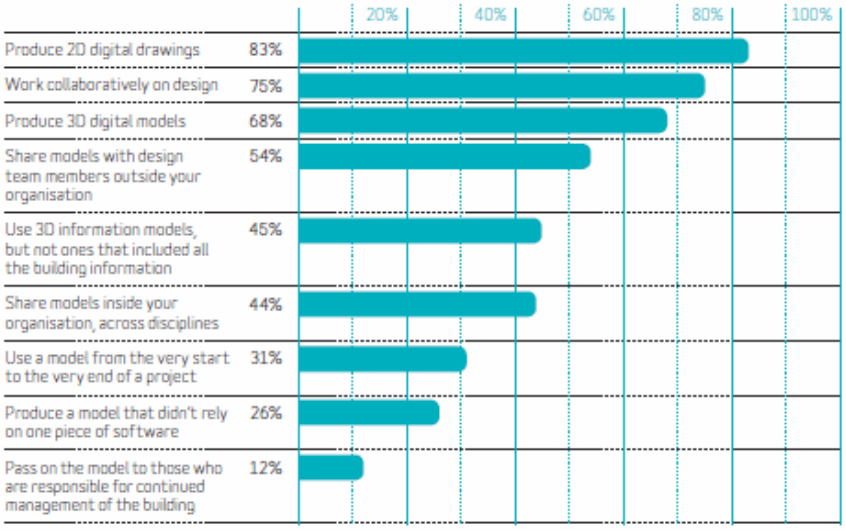
We also wanted to get a sense of what people were actually doing in the projects they had worked on, to see if BIM practice is embedded in the way people work, and whether traditional methods of working are still prevalent. We asked whether people had done the following in the previous year.

We found that 75% work collaboratively, and 68% produce 3D models. Fifty four percent share models outside of their organisations. These are criteria for Level 2 BIM. However, looking to further BIM maturity, less than a third use one model throughout the life of a project, or produce a format-independent model. Perhaps of most concern is that only 12% pass on the model to those responsible for the building. We will look at this again when we investigate COBie use.

Which of the following standards/publications does your organisation use?



Thinking about the projects you were involved in last year, did you ever?



IFC

"'Given that BIM is about collaboration, there needs to be much more cross-platform interoperability between software, and robust compatibility with IFC."

An effective BIM is one that allows for collaboration. This is increasingly important as we move up the levels of BIM. The format that allows models to be passed between disparate software formats is IFC (Industry Foundation Classes).

"'I use IFC as a format for federating models from differing authoring software."

"'During the design process we hotlink IFC models from the structural engineer, M&E guys etc. into our model for reference and for coordinated design advantages."

For BIM to be truly collaborative, both within and among organisations, we need to see an increasing adoption of IFCs. We are seeing steady, if unspectacular, growth here, with IFC adoption approaching 50% in 2014, up 4% from last year.

COBie

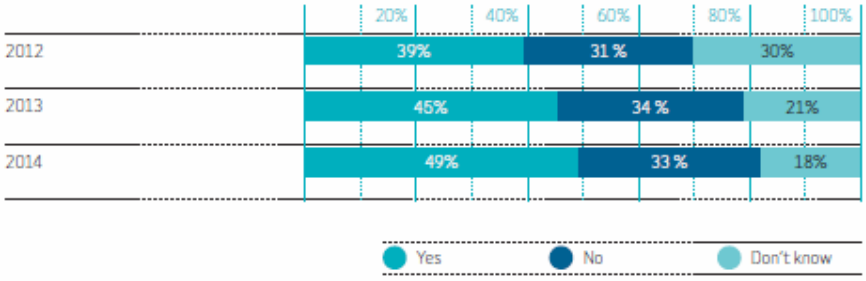
"'People need to realise that the BIM is for everyone's benefit - FM, letting agents, janitors."

COBie, however, is much less widely used.

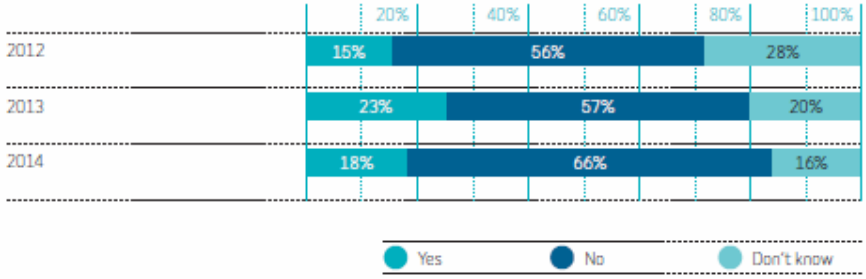
We see that fewer than one in five use COBie, a small drop from last year. If BIM is to deliver efficiencies throughout the life of a building, and not just in the design stages, we need to see a higher adoption rate. We have not explored whether this is due to difficulties with the format itself, or whether asset and facilities managers do not see a need for whole-life information models.

"'I know a lot of effort (and money) has been put into COBie, but the whole Excel sheet concept contradicts the fundamental principle of a common data environment."

Do you use IFC on your projects?



Do you use COBie on your projects?



Attitudes towards BIM

Over the years that the survey has been running, we have monitored people's attitudes toward BIM, whether they have adopted BIM or intend to. We have consistently found that most people are positive towards BIM – though there are pockets of scepticism.

The perception that BIM is the future of construction information remains, with nearly four fifths of people agreeing that it is. Small and medium practices are part of this future too, with only a quarter agreeing that BIM is 'just for larger organisations'.

There is still work for the industry to do in order to provide clarity for BIM, two thirds (67%) agreeing that 'the industry is not clear enough on what BIM is yet'. Aligned to this lack of clarity is a lack of trust. Only a quarter tell us that they 'trust what I hear about BIM', down a little from last year.

There is clarity in some areas though. BIM is not just software (you can't buy BIM in box), and it's not the same as a set of 3D CAD drawings.

There is a strong feeling that manufacturers need to provide their product information in a BIM-ready format, with more than three quarters (76%) agreeing that 'we need manufacturers to provide us with BIM objects'.

Finding out about BIM and BIM resources

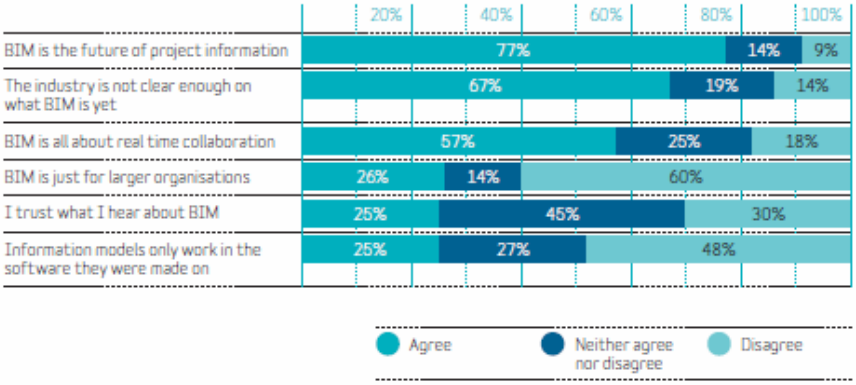
We continue to see that knowledge about BIM remains below the levels that people feel comfortable with.

"BIM is a great innovation and represents an exciting time for change in the construction industry, however more support is needed to help consultants across disciplines to adopt this."

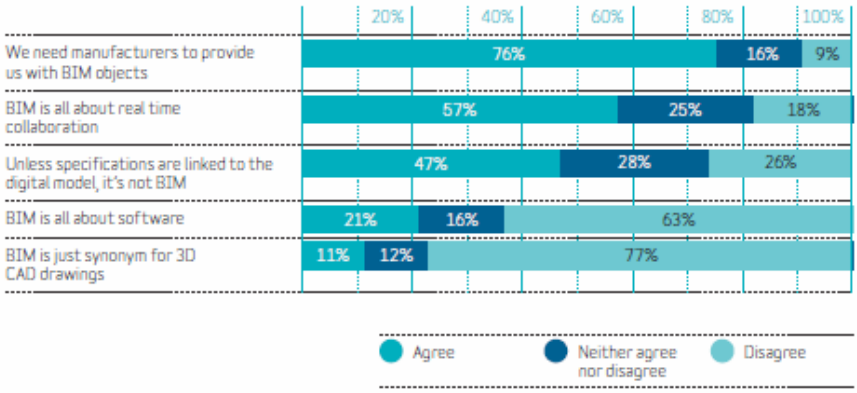
As in last year's report, around 45% of people describe themselves as confident in their knowledge and skills in BIM, but that leaves a majority who are either not confident, or who describe themselves as 'in- between'. There is still a need for BIM education among actual and potential users.

"[We need] education and training, with technical staff being the enablers within the companies (they will convince the management on the necessity of adopting BIM)."

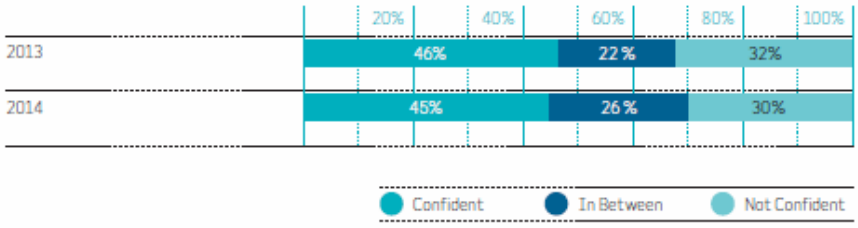
Attitudes towards BIM



How strongly do you agree or disagree with the following statements about BIM?



How confident are you in your knowledge and skills in BIM?



So where do people turn to get information about BIM? Top of the list is personal contact. Nearly three quarters turn to other professionals, whether colleagues (71%) or those outside of their organisation (73%). Specialists such as BIM consultants (43%) or the BIM Task group (62%) have a prominent role, and we are pleased that two thirds tell us that they turn to NBS for information. Professional institutes feature strongly too, especially among the professions they are there to serve. CAD vendors (42%) and CAD resellers (32%) are also used, but to a lesser extent.

"I am concerned also that particular software manufacturers are seeming to be suggesting that you will only achieve BIM compliance if you use their product. That is not the case."

An essential resource for well-developed models is the BIM objects that help make it up. At the moment, the design community is getting BIM objects from a range of sources. The most popular method is in-house creation and re-use (69%), followed by objects being created as needed for a project (63%). There are risks here, not only in the time taken to create objects, but also in the objects being non-standard, non-shareable outside of the practice, and when re-used, out-of-date. Each practice creating its own set of objects leads to a high level of duplication of work across the industry, reducing the efficiency gains that BIM can bring.

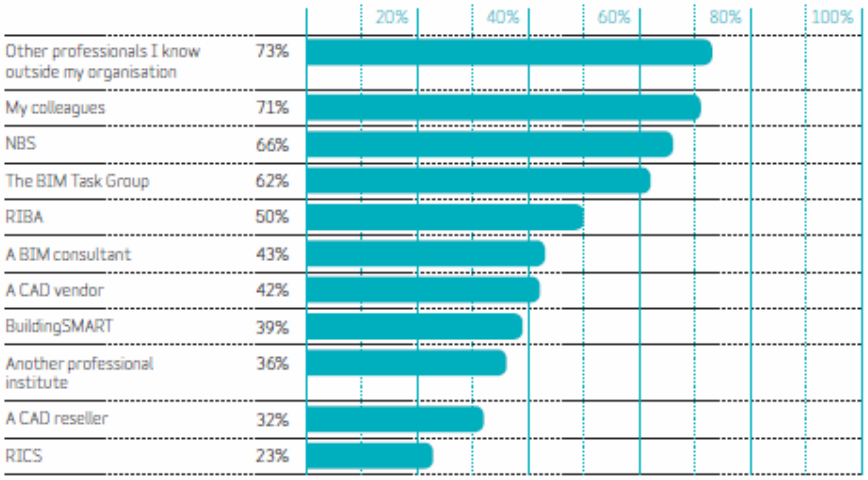
Manufacturers are a common source for objects, with 60% telling us that they source objects in this way. The design community is looking to manufacturers to help in the creation and implementation of BIM.

One way manufacturers can do this is through manufacturers' objects being made available on a free-to-use, publicly-available online library. The NBS National BIM library is the most well-used library, with nearly half (46%) of BIM users turning to it.

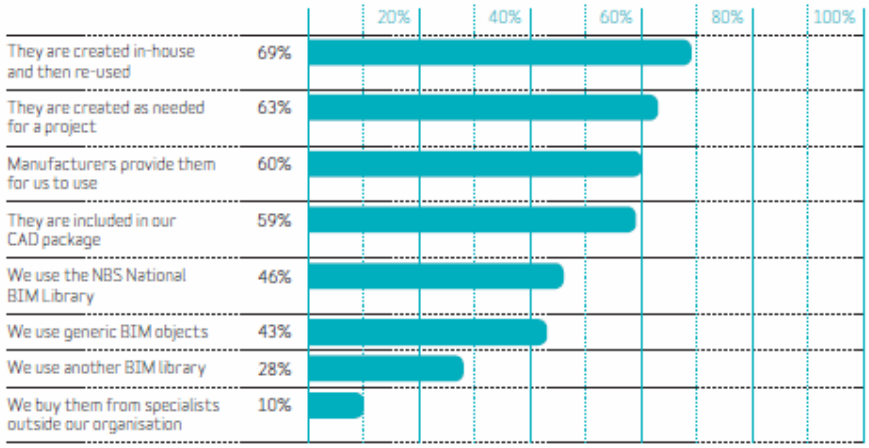
"Encourage suppliers to get their product range available via NBS library."

Using open libraries reduces the risk of objects going out-of-date, and so becoming inaccurate. It increases the opportunity for inter-company collaboration through using a common object source.

How likely are you to turn to the following sources of information about BIM?



Where do you get the BIM objects your organisation uses?



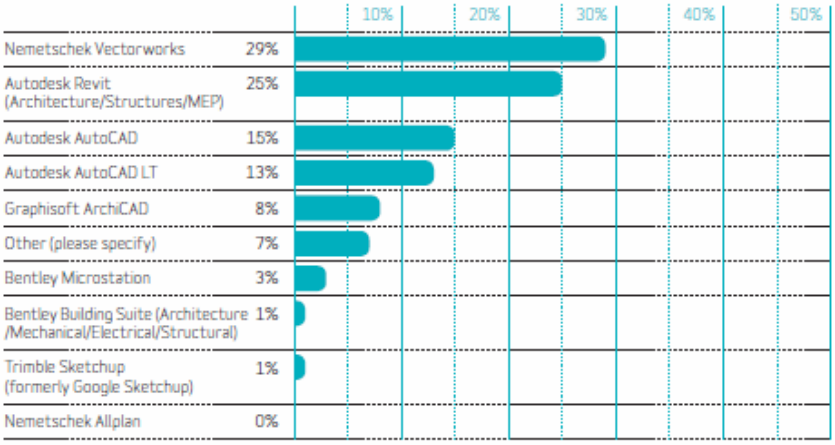
Software use

Since we started running the survey in 2010, Autodesk AutoCAD has consistently been the most used software package for building design in the UK. Last year Autodesk Revit took top spot, reflecting the increasing numbers producing fuller information models.

This year's survey results were a surprise.

Last year we noted that 'Graphisoft ArchiCAD and Nemetschek Vectorworks continue to have a loyal user base'. Analysis of the data suggests that this loyalty has translated into a significant increase of respondents to the BIM survey among Nemetschek Vectorworks customers, resulting in it being the most used piece of software among our respondents, with 29% using it. We suggest a little caution in taking this as a definitive description of the UK market.

When producing drawings, which of the following tools do you mainly use?



BIM experience

Barriers to adoption

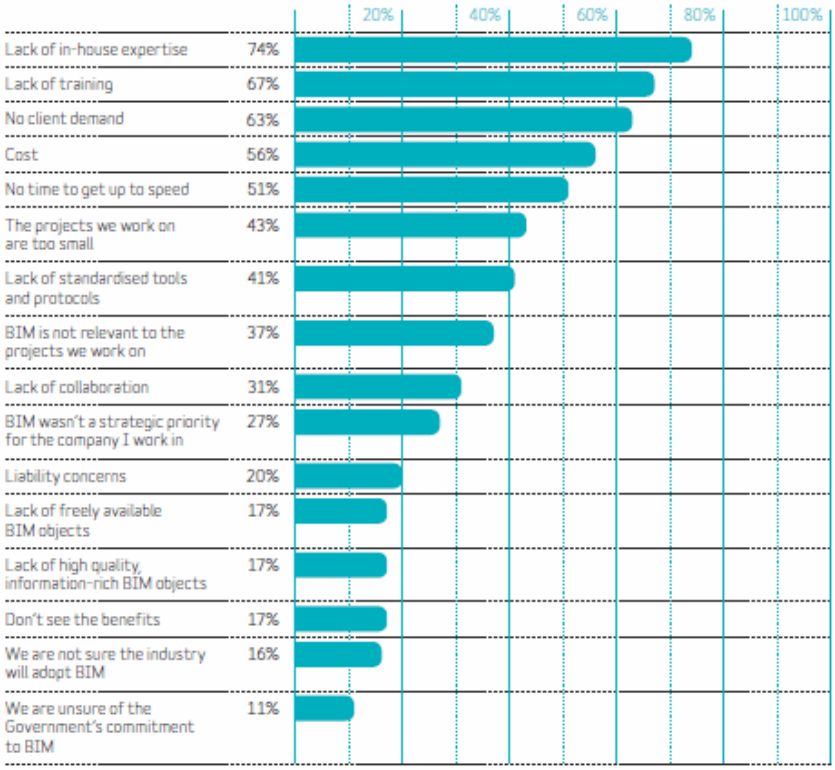
We asked those who were yet to adopt BIM what were the barriers to them doing so. The top two reasons link back to earlier discussions about a lack of confidence in BIM. Three quarters (74%) tell us that a lack of in-house expertise is a barrier, and two thirds (67%) tell us that a lack of training stands in the way. We know that the Government will require BIM - but not all clients will, or do. Lack of client demand is the third most cited barrier to BIM adoption.

Cost remains a barrier, but as the great recession recedes, another factor comes into play. As workloads increase, time becomes, literally, more valuable. Half of people who have yet to adopt BIM tell us that they don't have the time to 'get up to speed'.

"It's a question of time available to adopt - in a small business it's difficult to schedule in."

On the other hand, those who are yet to adopt BIM do not see it as a passing fad. Only 16% tell us that they are not sure that the industry will adopt BIM, and only 11% are unsure of the Government's commitment to BIM.

What are the main barriers to using BIM?



Users and non-users

We again looked at the views of those who have adopted BIM, and compared them with those who were aware of BIM but were yet to adopt. This allows us to make comparisons between expectation and experience. Once again, we found that the experience is better than the expectation. Those who have adopted BIM are more likely to be positive about it than those who have yet to.

There is strong, shared agreement that 'BIM requires changes in our workflow, practices and procedures'. Both those who have yet to adopt BIM and those who have done so see that adopting BIM is not an event, but a process that businesses go through. Business change is often difficult, and not always successful. But only 4% wish that they hadn't adopted BIM, although 19% would rather not adopt BIM.

"All new builds should be being built using the BIM process NOW."

"Architects have performed rather well for the past 200 years without BIM. Long may that continue."

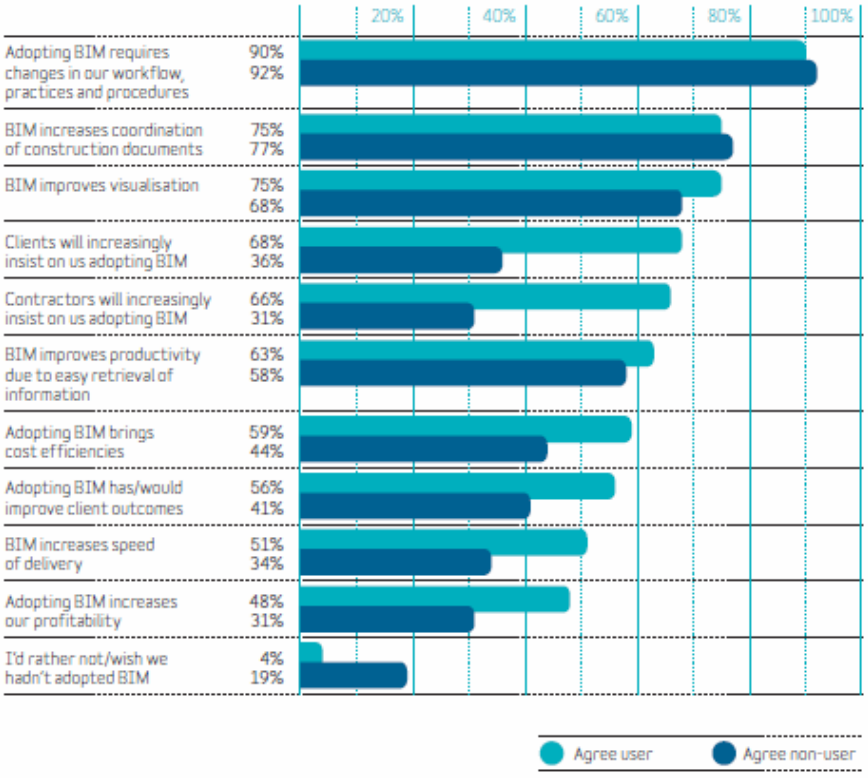
The benefits of BIM are clear to those who have adopted. Fifty nine percent see cost efficiencies, 56% an improvement in client outcomes, 51% an increase in the speed of delivery and 48% an increase in profitability. In every case, experience is better than anticipation.

According to those who have adopted BIM, there is a real and growing market for it: clients and contractors will increasingly insist on it.

This makes for a strong endorsement of BIM from the community of users: a more efficient and more profitable way of working that better meets the demands of a growing market.

"According to those who have adopted BIM, there is a real and growing market for it: clients and contractors will increasingly insist on it."

Attitudes towards BIM: A comparison of those who use it and those who don't



End note

This has been one of the more interesting sets of findings of our national BIM survey. Previously we have seen year-on-year growth in adoption, but this year, shortly before the Government mandate comes into force, we see a pause in BIM adoption. There remain a significant number of practices who do not see the advantages of BIM, and so choose not to adopt, or who are currently unable to adopt BIM because of time, cost or expertise. But the direction of travel remains clear – BIM will increasingly become the norm for the design and maintenance of buildings, and its widespread use is central to achieving the Government's construction strategy.

There is more going on here than an adoption of a particular set of technologies, standards and working practices to support an improved process for construction. Data collection, aggregation and interrogation, through collaborative working, is driving fundamental changes in how people work, across all sectors. It allows rapid learning, and increasingly sophisticated ways to form, test, and act upon evidence-based hypotheses. The construction industry is no exception to this. Younger generations are attuned to this, and perhaps it is they who will see BIM reach its full fruition.

"BIM is only one part of the solution – all the industry needs is a fundamental change in the entire way it works... it will be the next generation that is able to benefit. The Minecraft generation who are collaborating across the globe in creating online imagined worlds. Minecraft is my tip for what Level 3 is going to look like!"

PRILOGA 8: Rezultati NBS ankete 2016

BIM Survey: Summary of findings

Adrian Malleson
Head of Research, Analysis and Forecasting, NBS

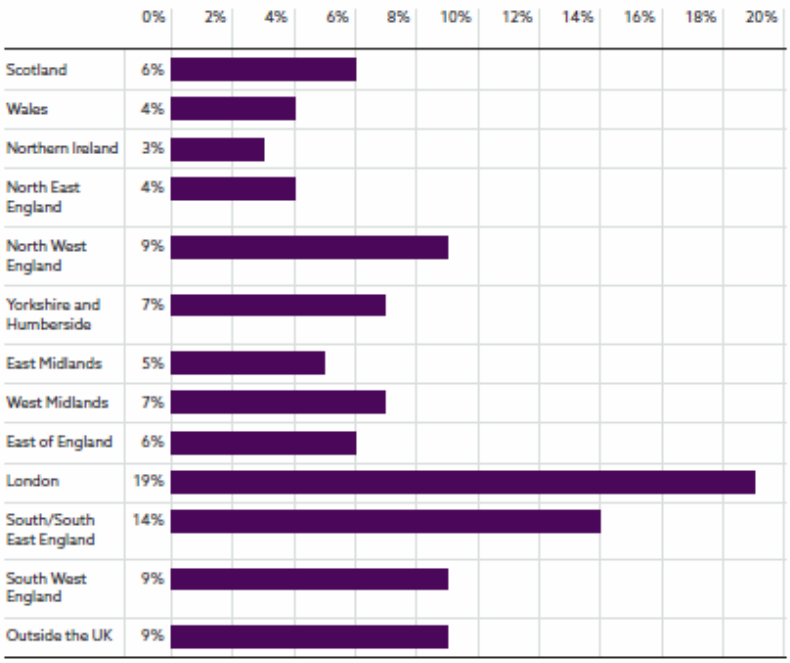
NBS

Welcome to the sixth NBS National BIM Report. It comes at a critical time for the UK construction industry; the survey was conducted shortly before UK Government implemented its BIM mandate in April this year.

In this report, we examine the themes of BIM adoption, BIM usage and people's attitudes towards BIM. We also take the opportunity to look more closely at the design community's assessment of the UK Government BIM mandate and its implementation. The mandate is coming, but does the industry welcome it, and is it ready?

We hope you enjoy reading the findings. We would like to take this opportunity to thank all those who took the time to complete the survey, without whom there would be no report. Thank you also to the professional bodies and institutes who publicised the survey to their membership. This helps makes sure that the findings cover the breadth of the design community. As collaboration is at the heart of BIM it is encouraging to see a broad range of bodies coming together for this report, to provide a holistic view of BIM.

Respondents by region

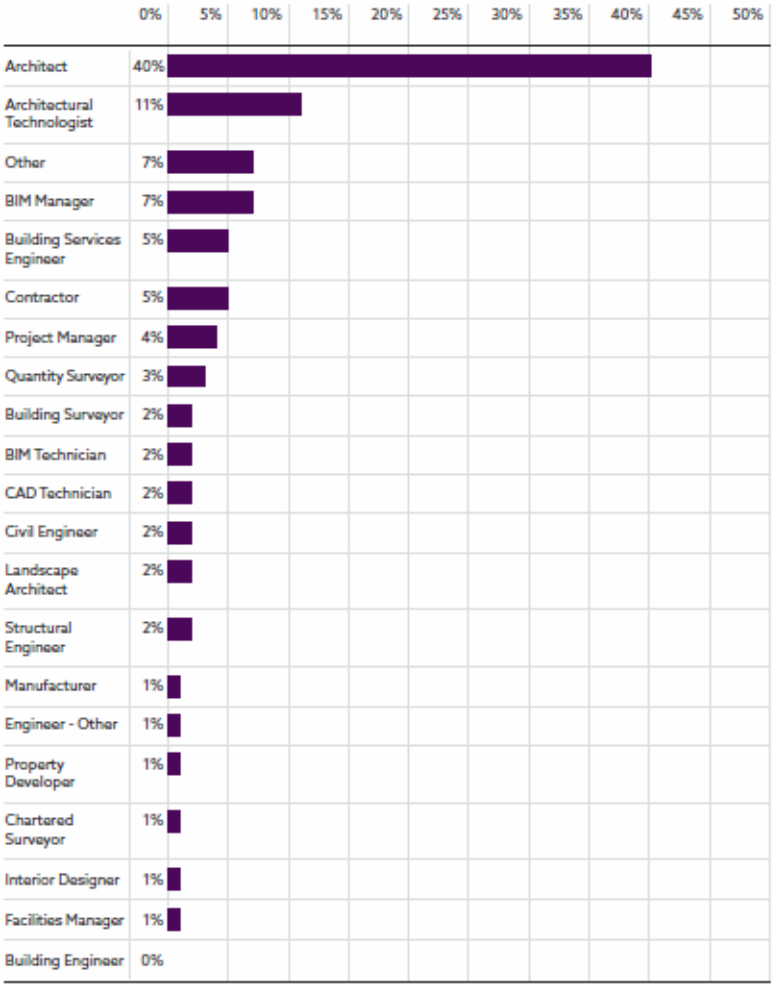


Findings in this report are based on just over 1,000 responses to the survey. Architects are the most strongly represented group. However, there is significant representation from other groups. These include, among others, Architectural Technologists, Building Services Engineers, Building Surveyors, Contractors, Project Managers and Landscape Architects. The number of BIM Managers who took part is notable. Six years ago, when we first ran this survey, the role barely existed. The representation is indicative of how embedded BIM has become.

For the first time we also asked about respondents' geographical location; so, for the first time, we are able to provide analysis of BIM adoption by the nations and regions.

As in previous years, we need to apply a little caution to the findings. As different people come to participate in the survey, and as roles change within the industry, our sample varies. Response to the survey is, naturally, voluntary. Therefore, we ought to remember that the findings are indicative rather than definitive. Nevertheless, this survey is the most comprehensive analysis of the state of BIM within the UK construction sector. Indeed, running this survey over six years, with a set of core questions that remain consistent, allows us to present a unique year-on-year comparison.

What is your main discipline?



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BIM usage and awareness

Firstly, let us turn to the headline figures of BIM adoption and usage within the UK. Last year we saw a slight, and unexpected, dip in BIM usage. This year we see that a majority of participants are using BIM.

Fifty-four percent of those who took part in the survey tell us that they are currently using BIM in some of their projects. Forty-two percent are aware of BIM, though are not using it. A mere 4% are unaware of BIM. This is significant. BIM has become a routine way of designing and constructing buildings. When we look back to 2011, only 13% of people were using BIM, 45% were just aware of it, and 43% did not know what it was. Whilst the rate of adoption has moderated, we have come a long way.

We went on to ask what those who were aware of BIM (whether using it or not) would do over the coming years.

We can see that BIM adoption is set to increase. Within one year, 86% of people expect to be using BIM on at least some of their projects. Within three years, 95% expect to be using BIM. Within five, that number increases to 97%. Should these projections be realised, then BIM will have become near universal and routine. The UK construction industry will have been transformed, in this respect at least. Again, we might wish to apply a little caution to these projections; intentions are not always realised. But it is clear which way it is going.

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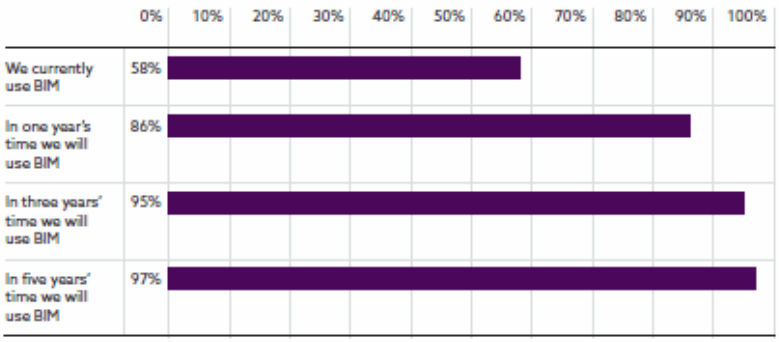
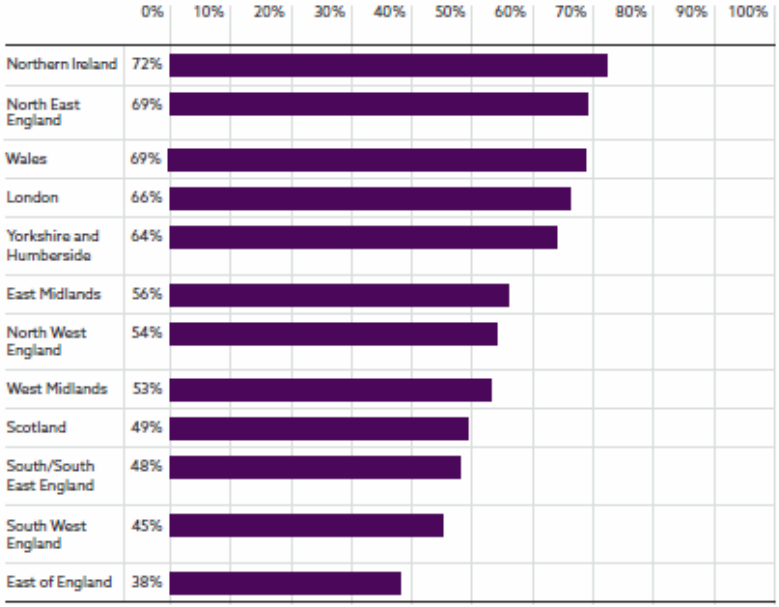
"BIM is the future. It is the way the coming generation will work. It will radically change the way we would go about doing our roles. Every effort must be made to implement it."

Asking people's work place location allows us to give a geographical breakdown of BIM adoption. For some regions, the number of respondents was relatively small, so the graph (below, right) needs to be taken as just indicative. It suggests that BIM is prevalent in London and the North East, as well as Northern Ireland and Wales. The area with the lowest rate of BIM adoption seems to be the East of England.

Projection of BIM usage among those aware of BIM



BIM adoption by nation/region



Finding out about BIM

"More work is needed in helping companies adopt BIM methods."

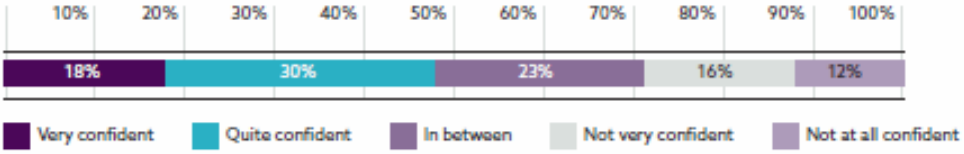
BIM requires new ways of working and, often, the adoption of new technology. Those looking to adopt BIM need to acquire the skills and knowledge to do so. We asked about people's knowledge and skills in BIM. It is a mixed picture. Whilst almost half (48%) tell us that they are 'very' or 'quite' confident in their knowledge and skills in BIM, there is still a majority who are not. Nearly a quarter (23%) describe themselves as 'in between', whilst 28% tell us that they are either 'not very' or 'not at all' confident in BIM.

People need reliable and readily available sources of information to acquire BIM knowledge and skills. We asked participants where they were likely to turn in order to find out about BIM. As we have seen in previous years, the most likely source of information is the one that's most readily available: professional colleagues. Seventy-one percent of people are likely to turn to immediate colleagues, while 57% turn to other professionals outside their organisation. Professional collaboration in action.

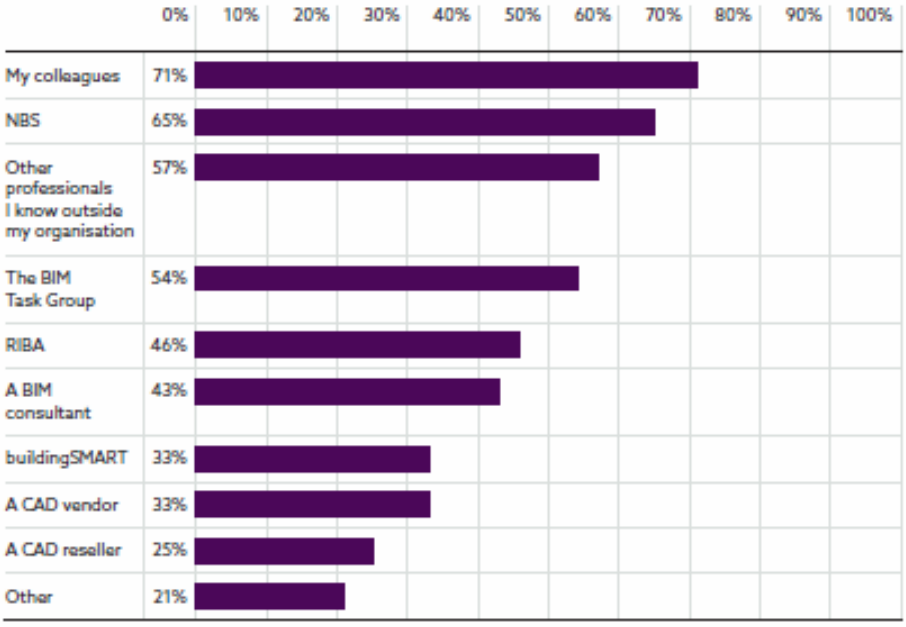
At NBS, we are pleased that 65% of people are likely to turn to us for information about BIM. This report forms just a small part of the range of tools and information we provide to assist with BIM adoption and usage.

Other notable sources of information include the BIM Task Group and the RIBA. BIM consultants and vendors also feature, but less markedly.

How confident are you in your knowledge and skills in BIM?



How likely are you to turn to the following sources of information about BIM?



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Use of standards

"The current standards and documentation are a fantastic set of resources."

Collaboration is at the heart of BIM. Effective collaboration requires the adoption and use of a shared set of standards; they provide the common environment within which collaboration can take place. They also protect against the anecdotal 'BIM wash'. Saying something 'is BIM', whether a project, a model or an object, isn't sufficient for it to be BIM. Adherence to relevant standards, on the other hand, is.

"The continued development of formal standards (BS / EN / ISO) should be driven forward."

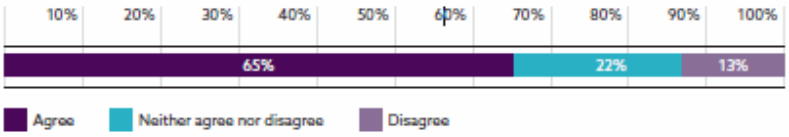
The industry is not yet convinced that BIM is sufficiently standardised. Sixty-five percent of respondents agree with the statement 'BIM is not sufficiently standardised yet'. Twenty-two percent 'neither agree nor disagree' and only 13% disagreed.

Whilst much work has been done on the creation and implementation of new standards, there is clearly more work to do. The data does not tell us if the perceived lack of standardisation is due to:

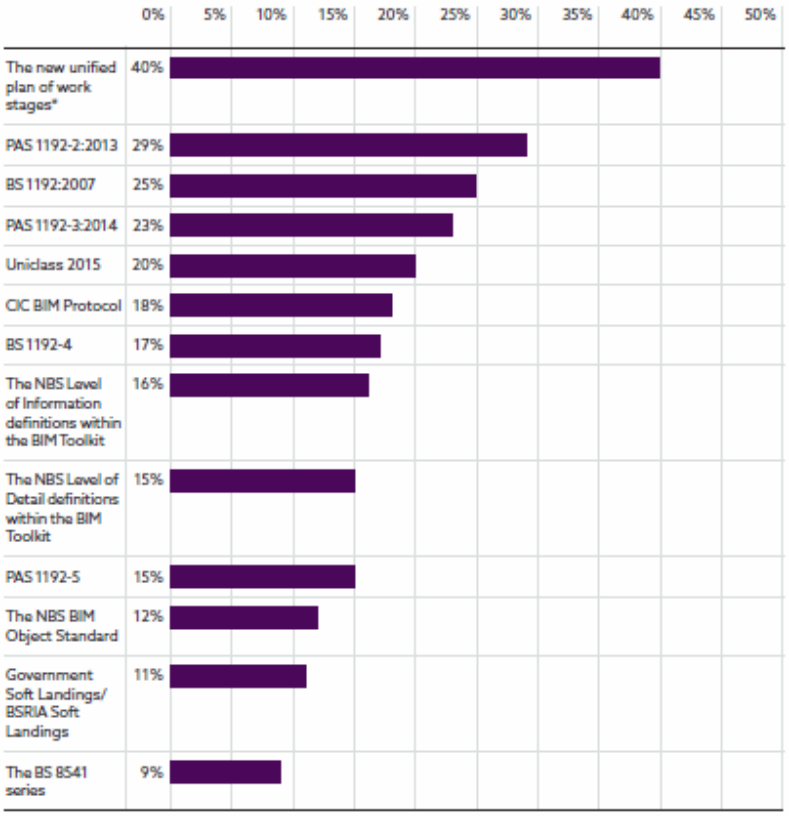
- a lack of adoption of existing standards
- existing standards not being fit for purpose
- our needing new standards to cover unstandardised areas

We asked about the standards being used. Forty percent use the new unified plan of work, such as the RIBA Plan of Work 2013. Twenty-nine percent use PAS 1192-2:2013, which gives the requirements for achieving BIM Level 2. Twenty-three percent use PAS 1192-3:2014, which describes using BIM for the operational management of buildings. Twenty-five percent use BS 1192:2007, a standard for the collaborative production of architectural, engineering and construction information. People are using standards, but fewer use the range of standards than have adopted BIM.

Agreement that 'BIM is not sufficiently standardised yet'



Which of the following standards/publications does your organisation use?



*e.g. the RIBA Plan of Work 2013

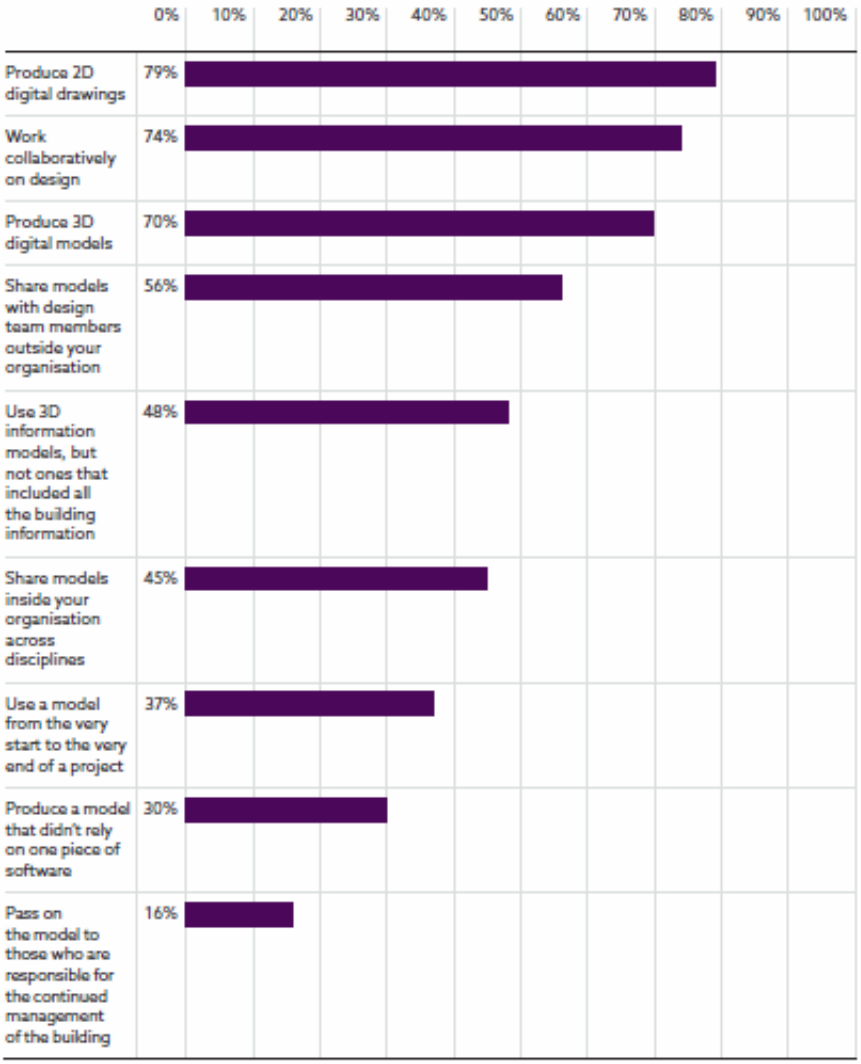
BIM practice

In this section, we look at how people are carrying out their design practice. We wanted to get a sense of the methods people use to create designs. The graph below shows that both newer and more established techniques have their place. Nearly 80% of people produce 2D models, though almost as many (70%) produce 3D models. These figures are very similar to last year.

As BIM is a collaborative process, it is good to see that almost three quarters of people have adopted collaborative techniques in the last year. This collaboration extends to sharing models: 56% of people share them with the design team members outside their organisation and 45% share across different disciplines.

"Enhance collaboration as a principle within the construction industry; reduce adversarialism."

Thinking about the projects you were involved in last year, did you...



A minority (37%) use models from the start of a project to the very end of the project, suggesting that, for most, using BIM is restricted to the design stages. Thirty percent produce a model that is software independent. Only 16% pass on the model to those who are responsible for the management of a building. We hope to see growth here; in principle BIM makes significant savings in the whole life costs of buildings possible through better, more clearly described maintenance and replacement schedules.

When producing drawings, Autodesk Revit is the most popular tool, followed by ArchiCAD, then Vectorworks. The range of tools used shows the need for a standardised non-proprietary format, and we look at this later.

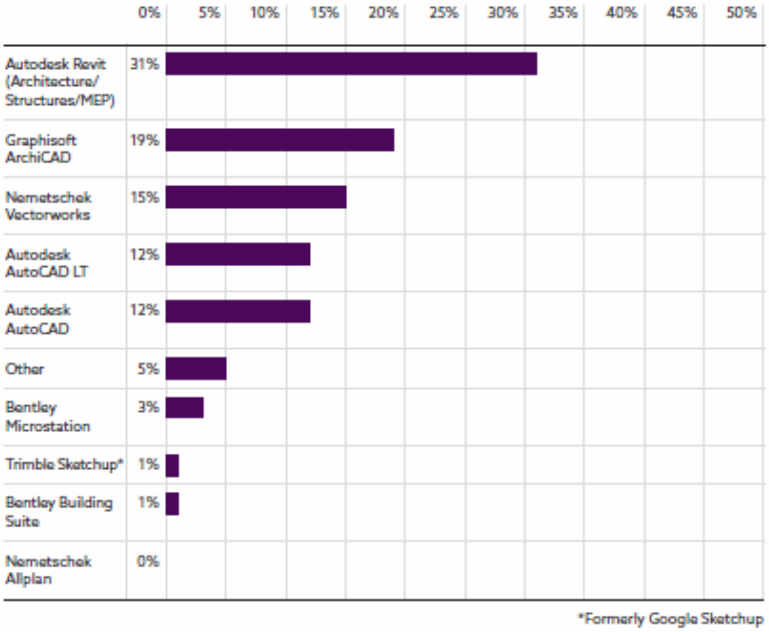
We also wanted to get a sense of what kind of buildings people design, and whether BIM is being used in some project types more than others.

The graph on the right needs to be read carefully. We asked BIM users what kinds of project they were involved in. We can see, for example, that 55% of BIM users were involved in private housing, 26% in public housing and 48% in education. We then went on to ask those involved in such projects whether they used BIM in them. So, to take private housing as an example, 55% of people were involved in private housing last year and, of those, 78% used BIM.

Taking the graph as a whole, we can see that people are generally more likely to use BIM in public sector projects, such as health, education and public housing. However, BIM is not restricted to the public sector. We see significant BIM adoption in private housing, private offices and private leisure, as well as other private sector projects. Even among those using BIM, it is not used in every project but it is used widely.

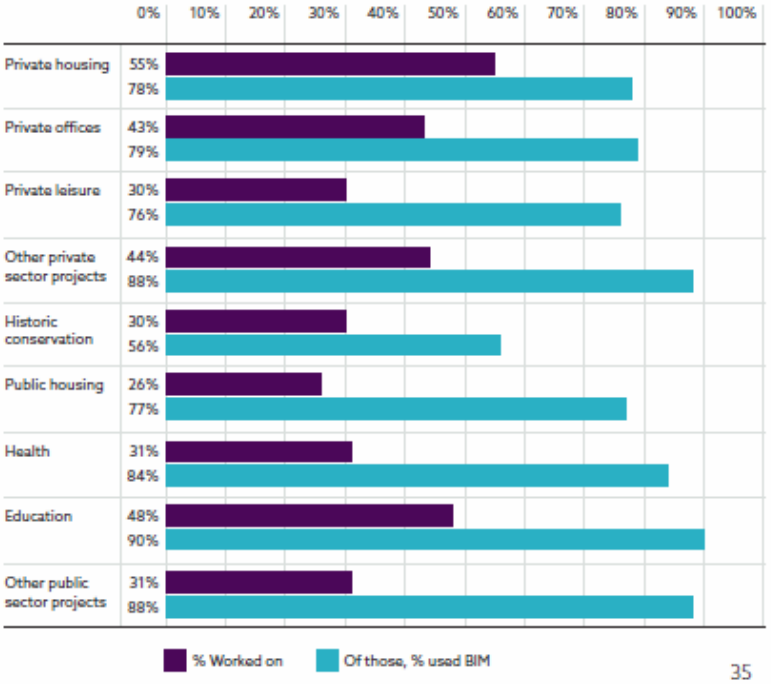
The government strategy of a BIM mandate for publicly-funded work that will go on to influence work in the private sector seems to be working.

When producing drawings, which of the following tools do you mainly use?



*Formerly Google Sketchup

Please tell us about BIM and the project types you were involved in over the last 12 months



Attitudes towards BIM

Since 2011 we have been monitoring people's attitudes towards BIM; whether they have adopted BIM or whether they intend to. People have been, and remain, positive towards BIM. Nearly three quarters see it as the future of project information. That said, within the free text comments we do also consistently find that there are a relatively small number of people who are resistant to BIM and do not see its benefits.

"Designers just keep getting more complexity pushed upon us. There needs to be clarity and value in the adoption of BIM for medium to small projects."

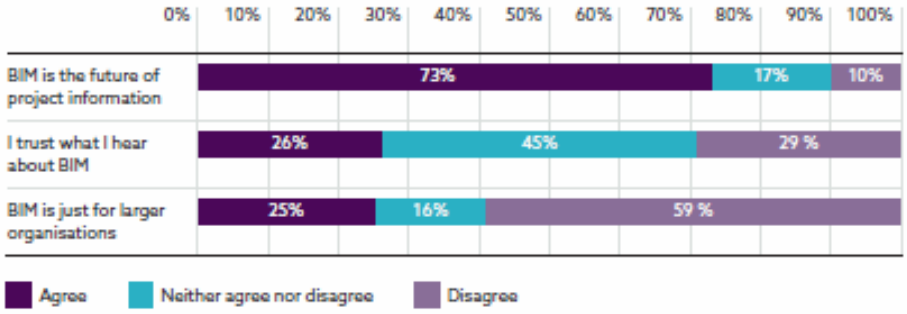
There is some ambivalence about how trustworthy information about BIM is, with less than a third saying they trust what they hear about BIM. A significant minority (though it is a minority) feel that BIM is just for larger organisations.

"BIM is great and it forces engineers and design teams to communicate properly."

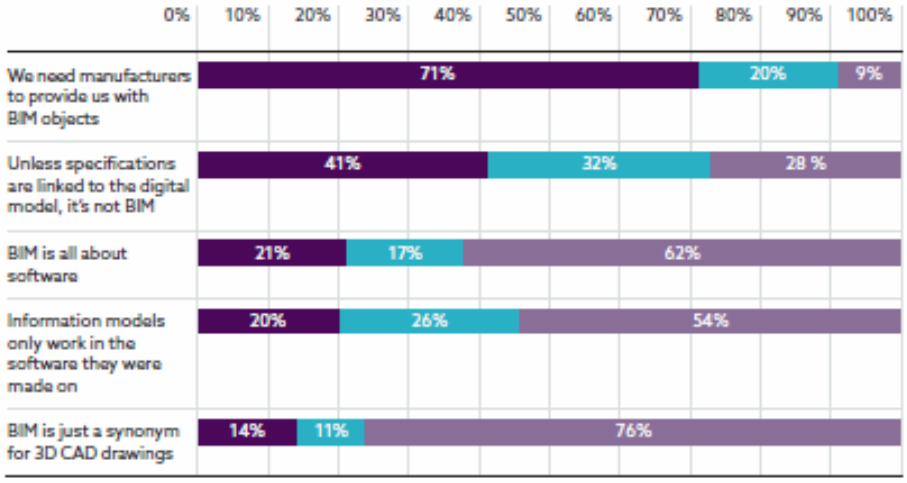
We have moved a long way from the time when BIM was often, and incorrectly, seen as being synonymous with software; 76% of people disagree that 'BIM is a synonym for 3D CAD drawings' and 62% disagree that 'it's all about software'. BIM tools are essential to successful BIM implementation though.

One set of tools the industry seems to lack is manufacturers' BIM objects. Seventy-one percent want manufacturers to provide them.

Do you agree or disagree with the following statements?



Do you agree or disagree with the following statements?



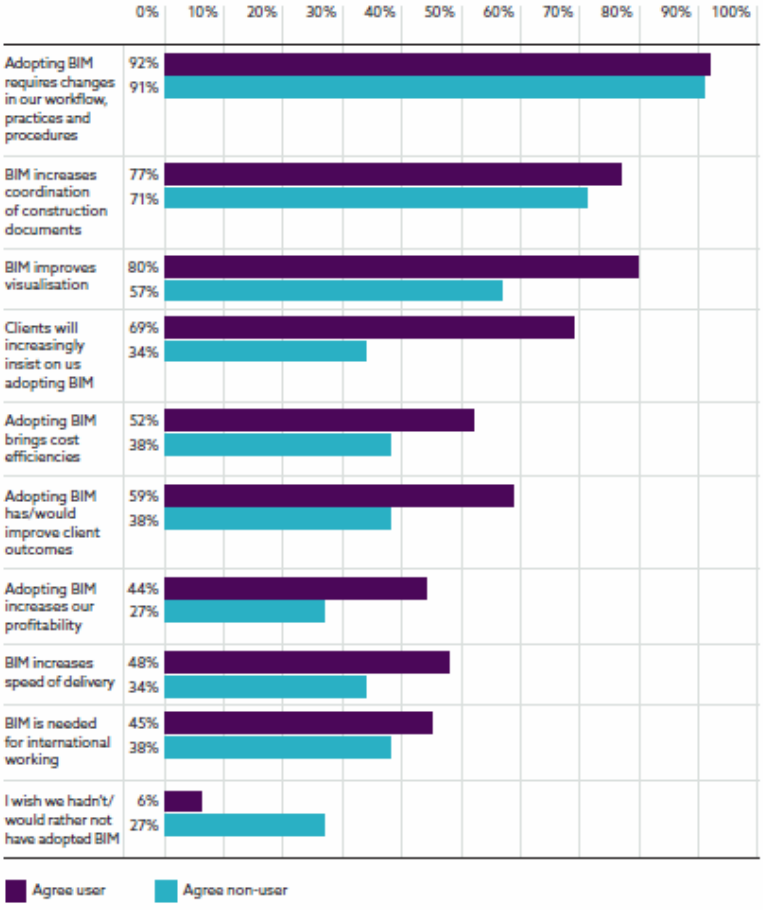
Earlier in this report, we spoke about those who had adopted BIM and those who had not done so but were aware of it. We asked these two groups a similar set of questions to find out whether there is a difference in their attitudes towards BIM.

We found near universal agreement that the adoption of BIM requires significant changes in how design is carried out; more than 90% of both users and non-users of BIM agree that it requires changes in workflow practices and procedure. Adopting BIM is not an easy thing. But the rewards are evident. BIM improves the coordination of construction documents and project visualisation, a clear majority tell us.

When we look at the graph in a little more detail we can see a striking feature; those who have adopted BIM are more likely to be positive towards it than those who have yet to. The majority of BIM users feel that it brings cost efficiencies and improves client outcomes. Indeed, 69% of those who adopted BIM tell us clients will 'increasingly insist' upon it. This contrasts with those who have yet to adopt BIM; here we can see that it is a minority, albeit a significant one, who feel BIM delivers these things.

More striking yet is the mere 6% of those who have adopted BIM and tell us that they wish they hadn't; once people have been through the BIM adoption process, they do not want to turn back. But those who have not used BIM are more cautious; 27% of those who have yet to adopt BIM tell us they would 'rather not'.

Attitudes towards BIM:
A comparison of those who use it and those who don't



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BIM survey: summary of findings

BIM experience

For BIM to flourish, its advantages need to translate into business benefit for design practice. Non-users see they will be 'left behind' if they don't adopt BIM, but the capital investment in software, training and changes in business process, leave a significant number feeling it is 'too expensive'.

"Small businesses are very worried about being able to afford BIM."

On the other hand, those who have adopted BIM tend to feel that they have done so successfully, and nearly two thirds feel that it gives them a competitive advantage.

Do you agree with these statements? Non-users

Do you agree with these statements? BIM users

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BIM and government policy

"This is a crucial moment for BIM as the number of full BIM Level 2 projects will start to increase with the government mandate coming into force very soon."

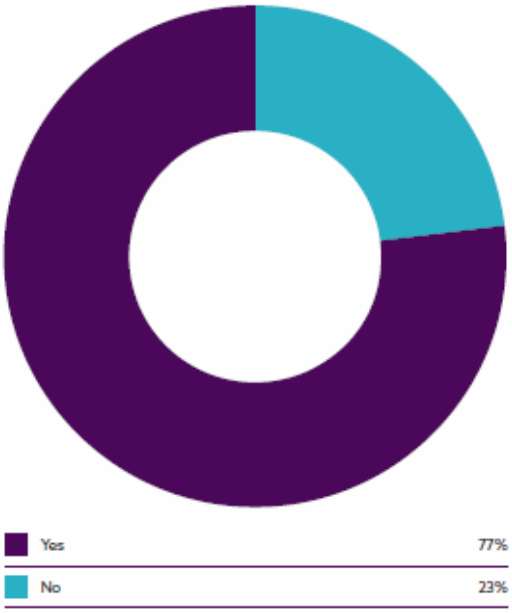
The survey was conducted at an important time - shortly before the UK Government mandate for BIM Level 2 to be used on all centrally-procured public sector projects came into force. We took the opportunity to look at people's assessment of the government policy and its implementation.

Firstly, let us look at the different levels of BIM. If BIM Level 2 is mandated, we might hope there is a wide understanding of what it means. Our first question was whether people were aware of these different levels. We found that over three quarters were. Of those who were aware, we went on to ask the highest level their organisation had reached on any project in the last year. Thirty percent had reached Level 1, and 65% Level 2.

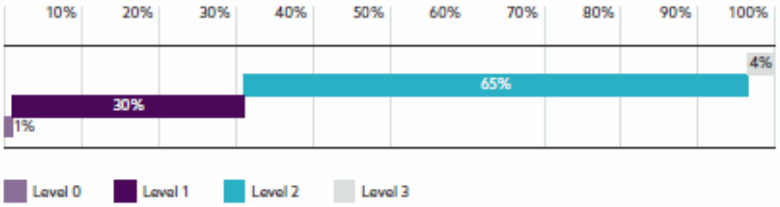
Very few said they had reached Level 3. BIM may come to deliver great benefits at Level 3, but for now it is, at best, imprecisely defined.

There is clearly still a need for learning about the defined BIM levels and what they entail, but we might read these findings, overall, as good news for the government strategy. If three quarters of those who are aware of the BIM levels have already reached Level 2, the industry was already in a good starting position before the mandate came into force.

The Government has described there being different levels of BIM. Are you aware of these different levels?



For those aware of the different levels of BIM, what level would you say is the highest level your organisation has reached on a project?



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BIM is collaborative. The file format that supports collaborative working, independent of software vendors, is IFC (Industry Foundation Classes). As collaboration takes place between broader groups within and among different organisations (perhaps geographically dispersed), an open, non-proprietary data environment becomes more important. We have seen strong growth of IFC use this year. In 2014 50% used IFC; now it's 63%.

COBie, however, remains less well used. In the last report we noted that if BIM is to deliver efficiencies throughout the life of a building, and not just in the design stages, we need to see a higher adoption rate. We wondered whether this was because COBie, when used, was not proving useful. This is not the case.

Of the small number who do use COBie, two thirds find it useful. The slow rate of adoption may be more a reflection of BIM models not being used through the life of a building and being restricted to the design stages.

"BIM has to be taken forward into the 21st century by everyone. Not just the designers, but the builders, users and maintainers. There is a real lack of skill set across the board as to people who know what to do with a COBie spreadsheet."

"We have not yet been asked to use COBie - most clients (even government departments) are barely up to speed with CAD drawings let alone COBie."

Do you use IFC on projects you've been involved with?

Yes	63%
No	20%
Don't know	16%

Do you generate COBie output for projects you've been involved with?

Yes	27%
No	54%
Don't know	19%

We also wanted an assessment of the Government's role in BIM adoption.

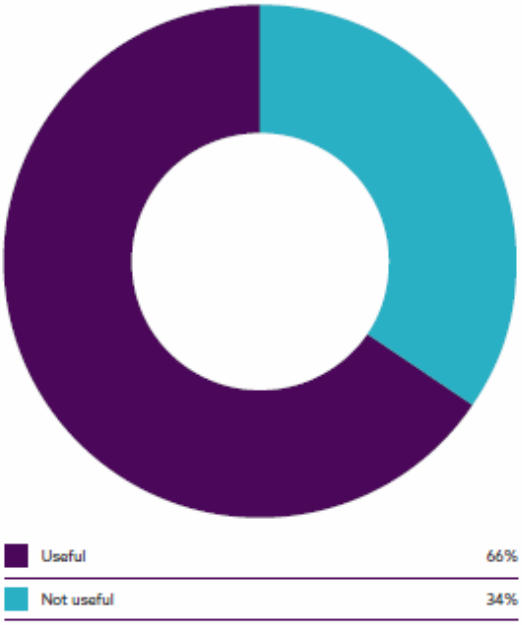
Overall we can see that people are clear that the Government is committed to BIM. Three quarters of people believe that the Government will make people use BIM for public sector work. Almost two thirds believe that the Government will require 3D BIM on its projects by 2016. Nearly half (48%) think the Government is on the right track with BIM.

"The Government's plan for BIM Level 2 on all projects was an ambitious target, and I feel the industry is slightly behind the curve."

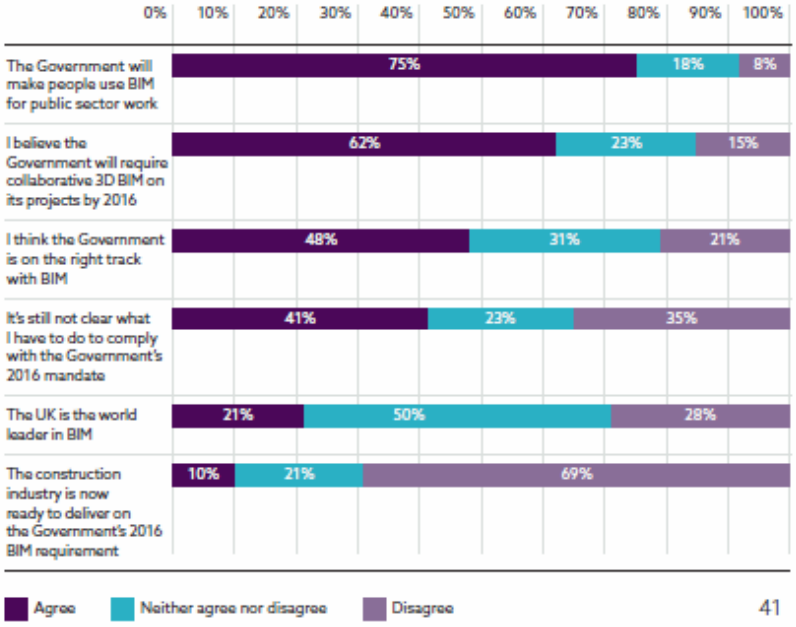
However all's not rosy. Forty-one percent tell us that they're not clear on what they have to do to comply with the BIM mandate, and only 10% tell us the construction industry is now ready to deliver on the Government's requirement. Whilst many governments, practices and individuals are looking from across the world for UK guidance on national BIM implementation, we do not see ourselves as world leaders. Just over one in five see the UK as a world leader in BIM, and over a quarter don't; half neither agree nor disagree.

So the assessment is mixed. The industry is clear that the Government will see through on its mandate, but perhaps the construction industry is not entirely ready for it.

How useful did you find COBie for delivering information about the management of the facility?



Do you agree or disagree with the following statements?



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BIM survey: summary of findings

Adrian Malleson
Head of Research, Analysis and Forecasting, NBS

Welcome to our seventh annual NBS National BIM Report. In the twelve months since our last report, we have seen the introduction of the UK BIM mandate. Collaborative working practice and BIM Level 2 data delivery is now a contractual requirement for work on central government-funded projects.

The NBS National BIM Survey gives a snapshot of the change the design community is both creating and going through. In this report, we examine some of the key themes the survey brings to light, and we point to some of the future changes to come. This year, we also spend a little time looking at the community's assessment of the approach the Government has taken to inject BIM into UK design practice.

As ever, our sincere thanks to the more than 1,000 people who took part in the research. By taking part, you have helped ensure that the UK has a reliable resource with which to assess BIM in the UK.

Those who responded to the survey came from a range of professions and practice types, and from all the nations and regions of the UK.

The UK Government and BIM

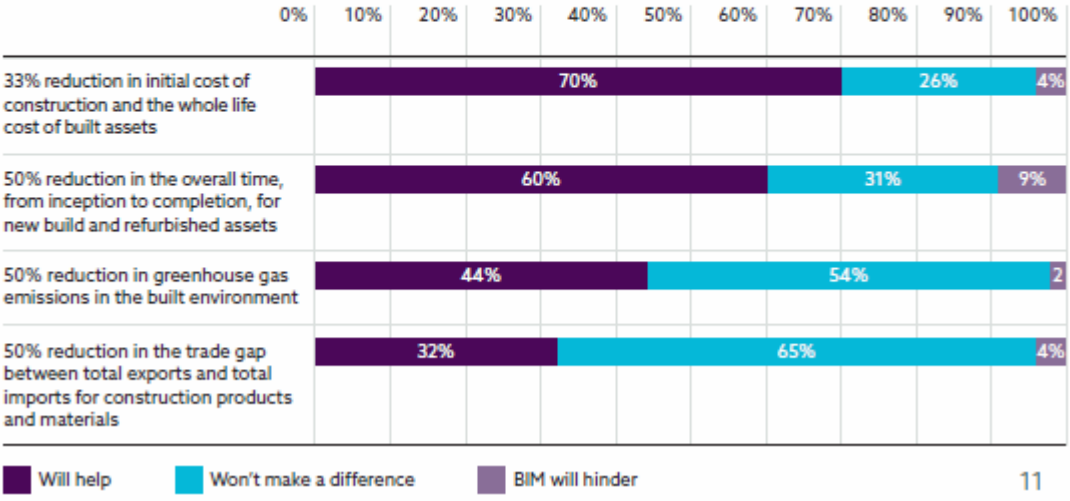
"The Government stated that all public funded projects needed to be BIM; this has played a big part in getting the majority of the sector to take note. I have to admit that a government can sometimes do good".

The Government's construction strategy

The UK's BIM mandate is strategic; it derives from the Government's construction strategy. Within the strategy are four ambitious targets. The role of BIM, in part, is to support our reaching them. The targets are for lower cost, more rapid delivery, fewer greenhouse emissions, and a better trade balance for construction products. The graph below shows the design community's assessment of BIM's ability to help meet those targets.

Very few think that BIM will stand in the way of our meeting these targets. Seventy percent see that BIM will help bring cost reduction in the design build and maintain life cycle. Sixty percent see that BIM will help bring time efficiencies, reducing time from inception to completion. Less pronounced is BIM's ability to reduce greenhouse gas emissions (44% agree that it will help), or improve the trade gap in construction products (32% agree).

Please tell us the role you think BIM will have in our achieving the following...



The Government's role in BIM strategy

Given the introduction of the BIM mandate, we took the opportunity to ask for a broader assessment of the Government's role in BIM strategy and implementation.

'The industry has mobilised to meet this mandate'.

A majority (51%) think that the Government is on the right track with BIM. Fifty-nine percent agree that the Government requires collaborative 3D BIM on its projects.

However, not everything is positive. A majority think that the Government is failing to enforce the BIM mandate.

'A lot of government agencies and bodies have used loopholes in contract form to get out of mandated BIM requirements'.

Over a third are not clear on what they have to do to comply with the BIM mandate.

'Everyone has their own version of what it means to meet the mandate'.

One issue came up repeatedly: clients are not sufficiently educated to allow the BIM mandate to flourish fully. This is not just among clients commissioning smaller works; it is among government departments too.

'The majority of government departments are still working out what BIM is and often have poor, uncoordinated documentation'.

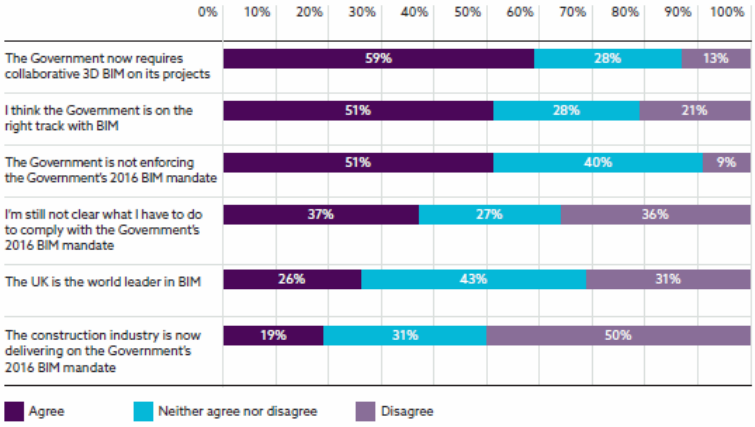
World leadership

'This whole sector approach to BIM will see the UK as the world leader in a new digitally built era, offering new ways of working, as well as massive growth potential both at home and abroad'.

Francis Maude, Government Construction Summit

The vision of the UK being the world leader in BIM has yet to be realised, according to the design community. Only 19% agree that we are the world leader. Perhaps the Government set the bar a little high? The UK is certainly one of a handful of countries that is leading BIM development and implementation. Other countries are looking to the UK to learn what we are planning, doing, and have done, to inform their own BIM strategy. So if not the leader, the UK is certainly a leader.

Agreement with statements



BIM usage and awareness

"I believe at least 50% of the construction industry has embraced it – that's quite a good result!".

Current use

BIM awareness is near-universal. BIM adoption is up. Those who have not adopted BIM intend to. The UK is well placed to have BIM as the most common project design environment within the next five years.

Awareness is near-universal, with 97% telling us they are aware of BIM (we solicit and receive responses from a wide range of design practices, not just the BIM community).

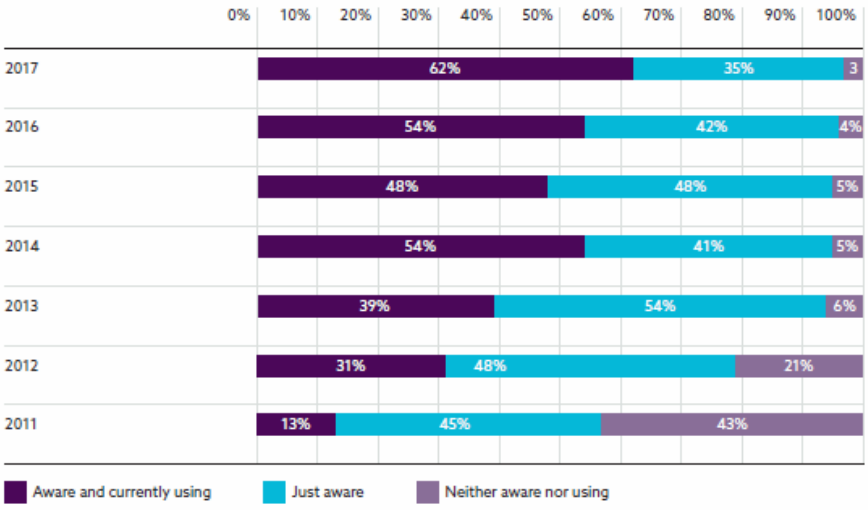
Sixty-two percent of practices now use BIM on some of their projects, up from 54% last year: an 8% year-on-year increase. Over the six years we have been running the report, BIM adoption has increased over 8% each year, on average. However, it was in the early years that the rate of growth was most rapid. That rate slowed somewhat between 2014 and 2016: a normal adoption curve in action.

The twelve months preceding this report have seen the most rapid BIM growth since 2014, suggesting that the UK Government's BIM mandate is having the intended effect.

BIM usage and awareness

Aware and currently using BIM	62%
Just aware of BIM	35%
Neither aware nor using	3%

BIM adoption over time



Adoption and practice size

We sometimes hear that BIM is 'only for large practices'. This is aligned to the view that BIM is useful for larger, more complex projects but not for less complex ones like domestic work (though many smaller practices create highly complex designs).

When looking at BIM adoption by practice size, we found that small practices (with 15 or fewer staff) were less likely to have adopted BIM than larger ones, though 48% had. For medium (16 to 50 staff) and larger practices (50+ staff), almost three quarters had adopted BIM.

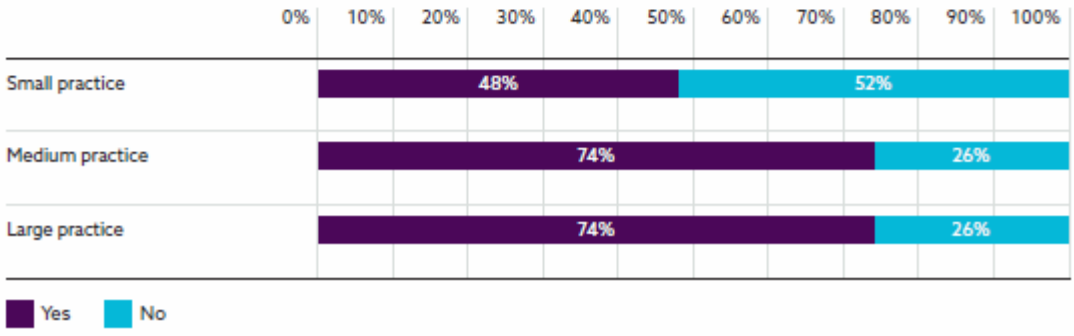
So, clearly, BIM is not just for larger practices – but small practices are less likely to have adopted BIM.

Frequency of BIM use

Of course, adopting BIM does not necessarily mean using it for every project. For the first time, we explored the percentage of projects that were designed using BIM. We asked those who had adopted BIM 'Approximately what percentage of projects have you used BIM for in the last 12 months?'

The graph to the right shows the response to this. It shows us that 18%, nearly one in five, use BIM on every project they work on, and 29% use BIM not on every project, but on more than 75% of their projects. To describe the findings another way, one third who are using BIM do so on a minority of projects, and two thirds use BIM on a majority. Once BIM is adopted, it is usually the design methodology of choice.

Within your organisation, have you adopted BIM for projects you've been involved with?



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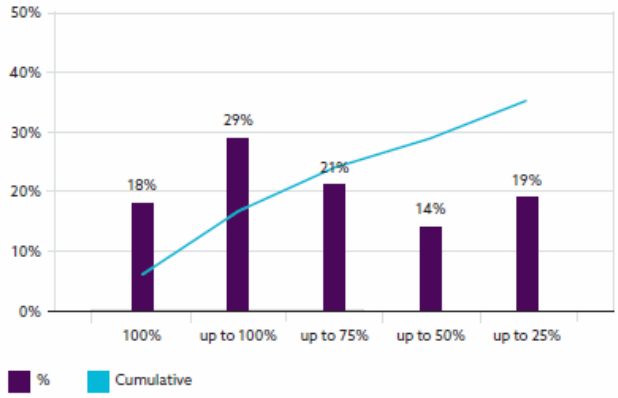
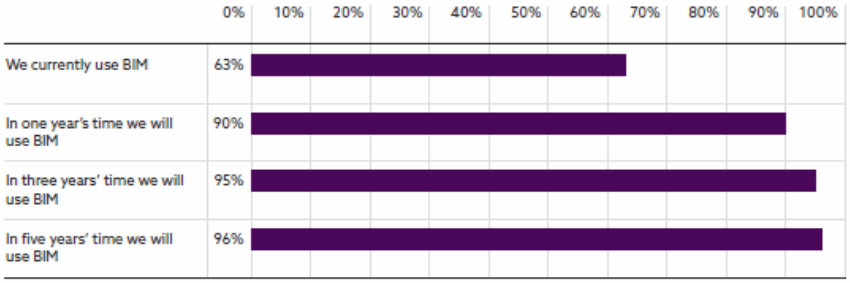
Approximately what percentage of projects have you used BIM for in the last 12 months?



How would you describe your organisation's future use of BIM?



Future use

We ask those who are aware of BIM about their intended BIM use, and whether they will adopt BIM in the coming years. We find that the intention among the design community is for near-universal BIM adoption, and soon.

There are a couple of things to note here. If people's intentions are realised, 90% will be using BIM by next year, and within three years almost all practices (95%) will. Intentions are not always realised though, and over the last few years we have seen an emerging pattern of actual BIM adoption falling short of what is anticipated.

So where does this leave us? The first thing to note is that the possibility of BIM adoption is not being dismissed. People intend to adopt BIM but, for whatever reason, are not at present (and we will look at this later). Secondly, as we have seen, BIM adoption is steadily rising. If it's taken six years for 60% to adopt BIM, then reaching 95% in another five years begins to look realistic (more realistic, perhaps, than 90% by next year). We will see.

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BIM maturity

In order for BIM to be implemented effectively, at both a national and practice level, it is essential that designers have the skills they need to work effectively with BIM. Year on year, we have been monitoring confidence levels of people's knowledge and skills in BIM. Looking at the graph on the right, we can see that, for the first time, a majority describe themselves as confident in BIM. Fifty-five percent are confident and 23% are not.

Back in 2012, only 35% described themselves as confident in BIM, and 40% were not confident. It is taking time, but gradually the skills and expertise needed to make a success of BIM are becoming more widespread.

Where are these increasing levels of skills coming from? Fittingly, as a collaborative process, people learn skills in BIM through other professionals. Three quarters turn to colleagues within their organisation for information about BIM and 62% turn to other professionals outside their organisation. The information that professional bodies and expert organisations make available (often at no cost) is important too. NBS, the BIM Task Group, BSI and the RIBA, among others, are significant here. As we have seen before, people turn less often to CAD vendors and re-sellers.

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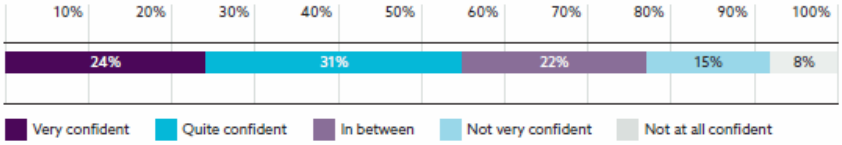
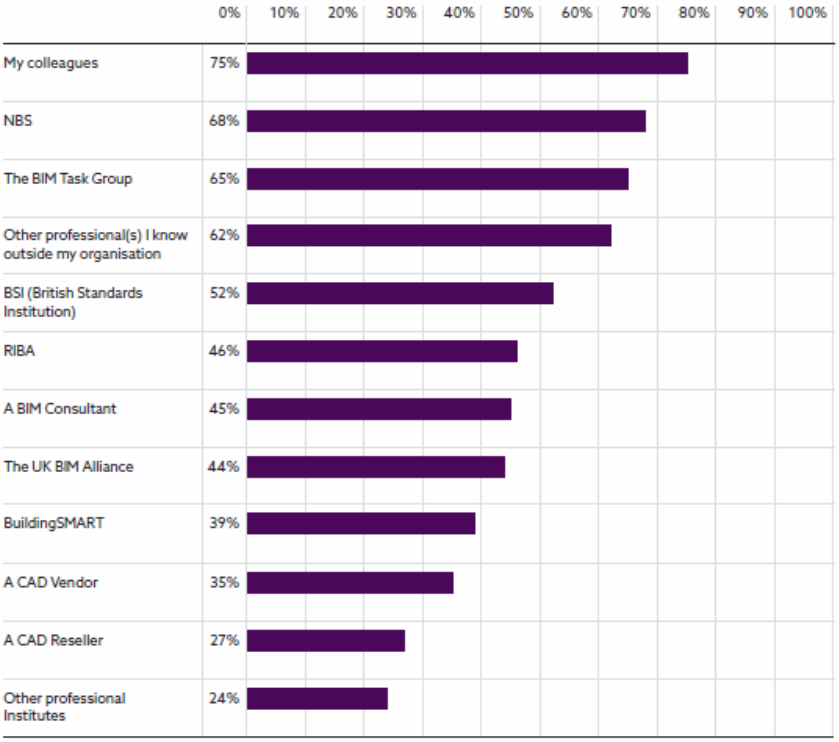
How confident are you in your knowledge and skills in BIM?



How likely are you to turn to the following sources of information about BIM?



BIM levels

BIM adoption is progressive, and often described as a 'journey'. The milestones on that journey are the BIM Levels. Not all Levels are clearly described yet: BIM Level 3 and beyond are works in progress. But by describing different BIM Levels, and mandating Level 2, the Government mapped out a clear direction of travel for the industry.

In 2012, not everyone had seen that map. Only 51% were aware of the different Levels of BIM. Since then, awareness has grown significantly: 85% are now aware of the different BIM Levels.

We asked which Levels of BIM people saw themselves as having reached. Twenty-two percent told us that they had reached Level 1; Level 1 is where designers typically create 3D models, and share information through a common data environment. Seventy per cent told us that they had reached Level 2; this is the mandated level in which 3D models are created and collaborated on through, for example, a federated BIM model.

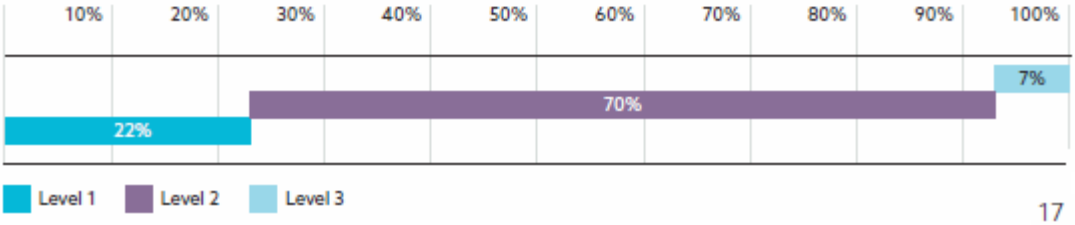
'The government will develop the next digital standard for the construction sector – Building Information Modelling 3 – to save owners of built assets billions of pounds a year in unnecessary costs, and maintain the UK's global leadership in digital construction'.

Budget 2016 Policy Paper.

Seven percent tell us that they are at BIM Level 3; so full collaboration between all disciplines by means of using a single, shared project model. It is fair to say that the full definition of what constitutes BIM Level 3 has yet to be worked out and standardised. Those describing themselves as being at Level 3 are perhaps best seen as those pushing collaborative BIM to its fullest current potential.

In any case, more than three quarters of organisations who have adopted BIM are at or beyond the Level required by the BIM mandate.

What level would you say is the highest level of BIM your organisation has reached on a project?



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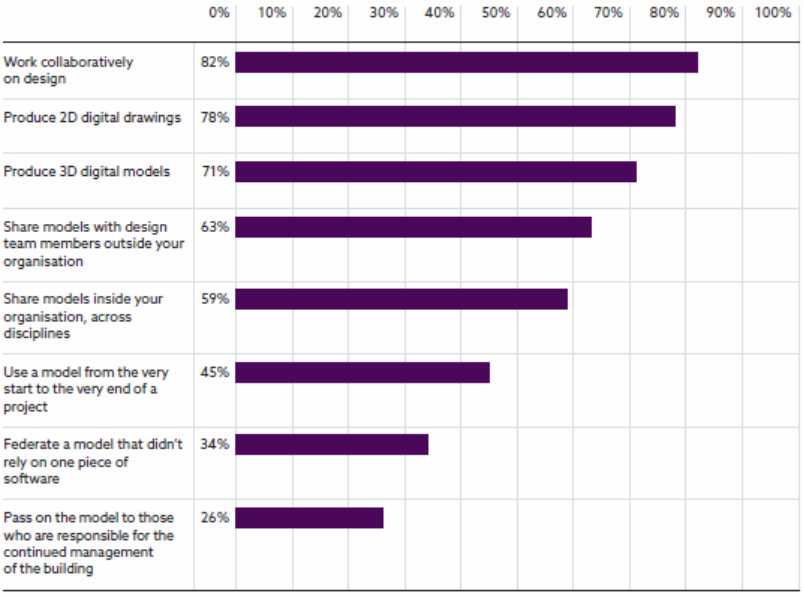
The self-descriptions of the levels attained are mirrored in working practice: working collaboratively on design is standard practice. 3D models are routine, produced by 71% of respondents. Sharing models is common within and outside organisations, with 59% and 63% doing so respectively. Within the design stages, we can see that the BIM practice of collaboration and model sharing is now commonplace.

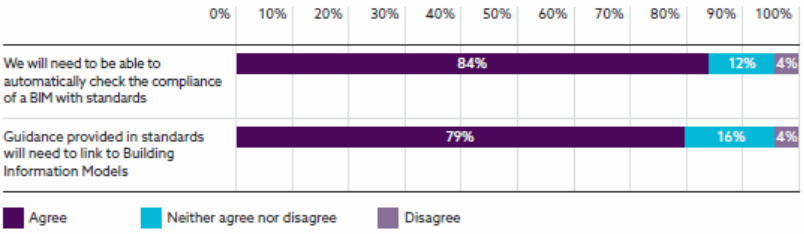
We can also see the challenge of future work to be done. Much of the potential value of BIM lies in its application to later stages, to testing the practical efficacy of a design. By using a BIM to gather and evaluate the performance of a design through construction and use, later designs can be refined and improved in light of the information gathered.

This data-driven, real-world testing and refinement cycle is commonplace in other industries, but we see it less in construction. Only 45% use a model from the start to the end of a project, and only 26% pass on a model for building management. The value of the information embodied in BIM is yet to be fully realised.

Thinking about the projects you were involved in over the last 12 months, did you ever....



Do you agree or disagree with the following statements?



Use of standards

BIM is collaborative. Standards describe the shared process, structures and definitions that allow collaboration. For collaboration to be successful, collaborating parties need to adhere to agreed standards.

The graph below shows the standards and publications that people are using to inform their BIM processes. It is striking that whilst a majority have adopted BIM, no one standard is used by a majority.

BS 1192:2007+A2:2016, which describes the collaborative production of architectural, engineering and construction information, is the most commonly used (by 39%). PAS 1192-2, which specifies requirements for BIM Level 2, is the next most commonly used (38%). Over a third of organisations use the unified work stages, such as the RIBA Plan of Work.

It looks like there is work to do to bring about wider adoption and use of these standards and publications. That work is already underway: the RIBA Plan of Work, with an accompanying toolbox, is freely available at ribaplanofwork.com. The core standards are freely available at bim-level2.org/standards

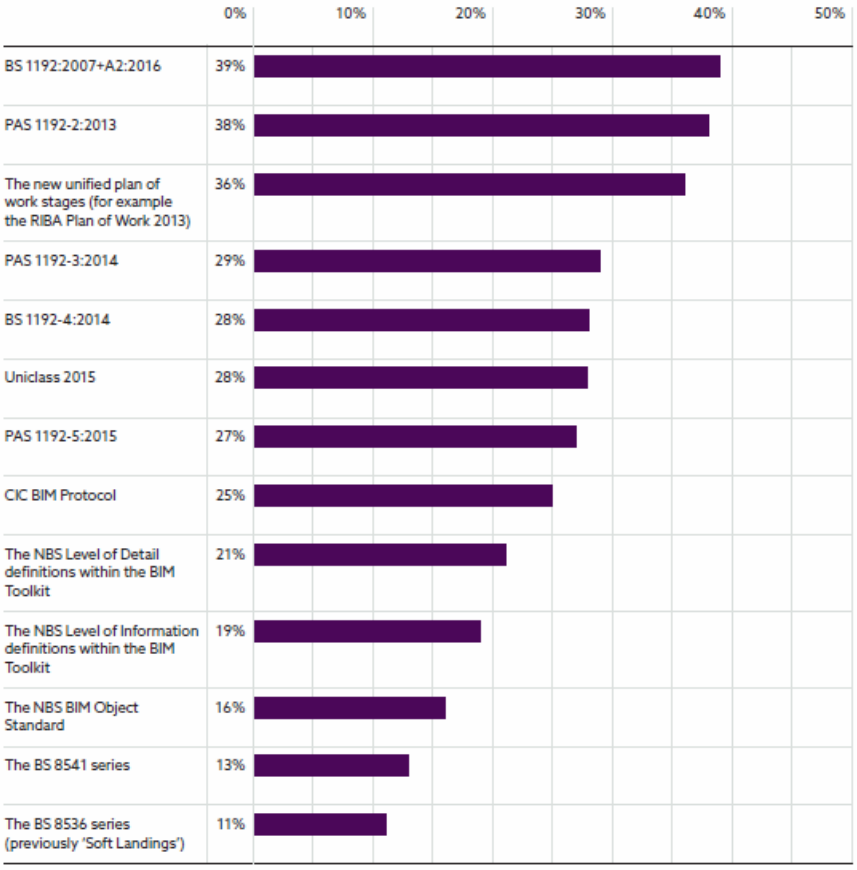
Then again, there is some resistance to the growing list of BIM standards *'We just need to cool it on all the standards'.*

There are standards about BIM, and there are standards about buildings and the products that make them up. For the latter, these standards are an integral part of construction information. They are a part of the 'I' in BIM, just like geometric information, specifications or product information.

Like other design and construction information, information about, and from, standards will need to be embedded within a BIM.

Eighty-four percent see automatic compliance checking as a future need, and 79% see the need for a link between standards and BIMs.

Which of the following standards/publications does your organisation use?



BIM resources

Whilst at its core BIM is a structure within which people can work collaboratively, that structure has many component parts. Among them are: BIM objects, modelling software, standard workflows, contractual arrangements, specifications, and the regulatory and standards environment. We explored these themes a little.

For BIM objects, the message is clear: the design community needs manufacturers to provide BIM objects. It also needs well-structured generic objects. The NBS National BIM Library provides both of these.

Standards need to be placed within the BIM environment, ideally accessible via BIM software tools.

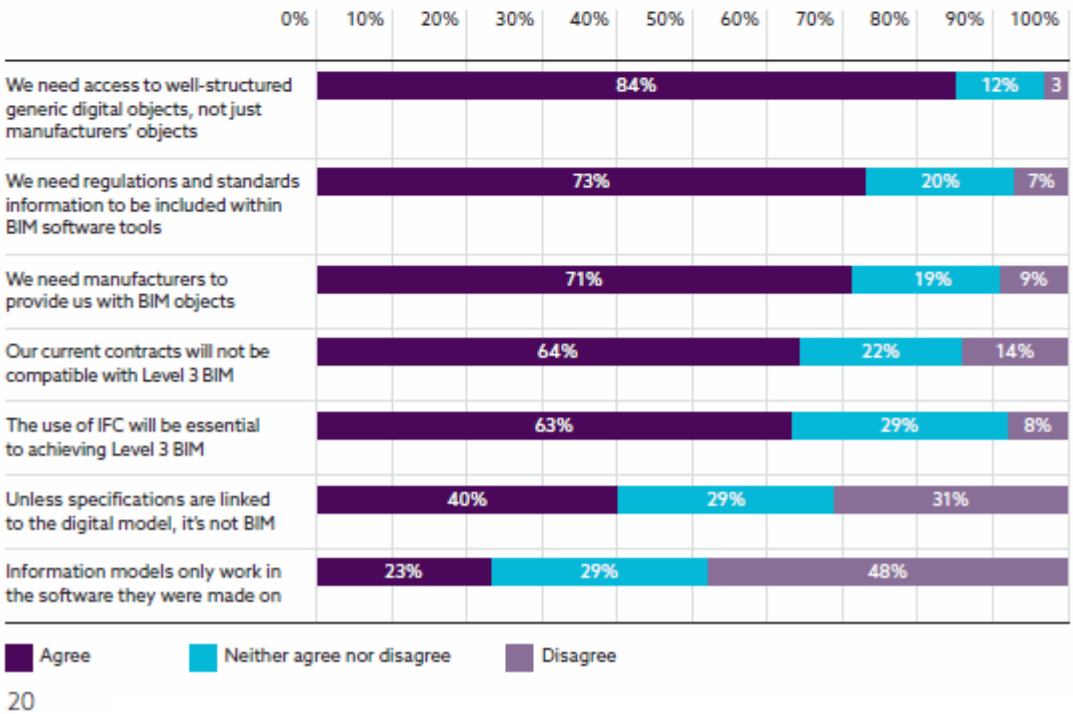
Specifications contain a level of design information not held in a CAD package, so will increasingly be linked dynamically to the BIM.

Contracts need to increasingly reflect the collaborative BIM reality, particularly as we move to Level 3.

'Contracts need to be (re)written with BIM in mind. Design and Build procurement especially works against BIM workflows'.

Similarly, as we to move to Level 3, frictionless movement of BIMs between software packages is essential, and IFCs are the way to do this. Currently 71% use IFC on their projects, a level of adoption that provides a firm base for greater future use and functionality.

Agreement with statements



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COBie

Whilst a majority now use the IFC file format, fewer (42%) use COBie (Construction Operations Building information exchange). Like IFC, COBie is a non-proprietary data format. It is there to help deliver the asset information held within a BIM, so that a building can be better managed through its life. A majority of those who do generate COBie output find it useful for delivering information about the management of the facility. So why aren't more people generating COBie output?

'We haven't yet had a client request for this information'.

We asked, and the most common response by far was lack of client demand. Many clients don't know what a COBie output is, and wouldn't know what to do with it if they got it. This may evolve as BIM is pushed beyond the design stages.

That said, a number of respondents raised the issue of COBie generation requiring time and expertise from those creating the BIM. This needs to be paid for.

'Additional time and resource required to compile COBie makes it un-feasible unless specifically requested and included within the agreed fee'.

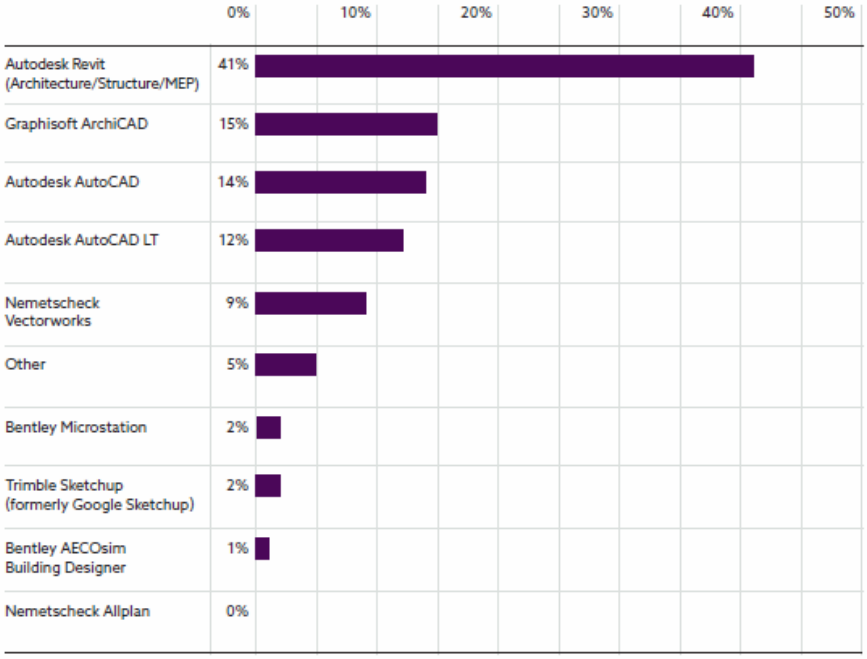
Do you generate COBie output for projects you've been involved with?

Yes	42%
No	58%

How useful did you find COBie for delivering information about the management of the facility?

Useful	60%
Not useful	40%

When producing drawings or models, which of the following tools do you mainly use?



21

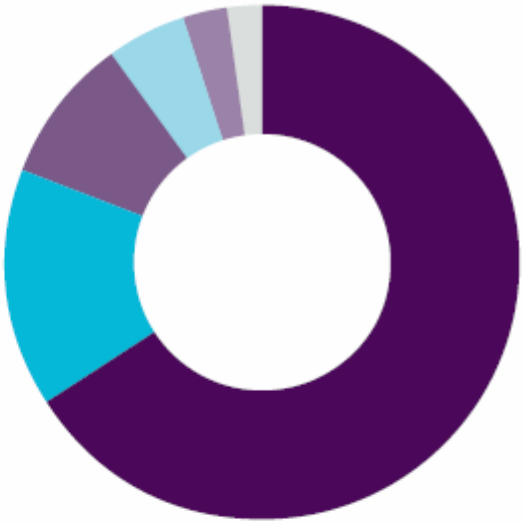
Software Use

As part of our BIM Survey, we have consistently asked which software tools people use. In 2014, we saw Autodesk Revit overtake Autodesk AutoCAD, as designers increasingly created information-rich models, rather than simply geometric representations. Now 41% of those who took part in the survey use Autodesk Revit, well above AutoCAD.

Autodesk dominates the UK market, with 66% using an Autodesk product. Revit is not the only option though: other vendors such as Graphisoft, Nemetschek and Bentley have a significant user base.

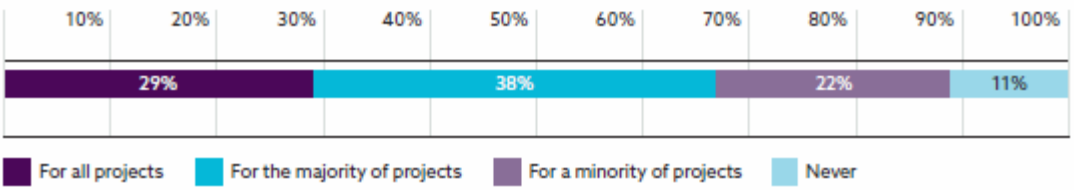
Whilst modelling tools become increasingly sophisticated, sound design will continue to rely on well-written specifications. Increasingly, these need to co-ordinate with the drawings and models to ensure consistency of design information. More than two thirds of respondents are co-ordinating specifications and models/drawings on the majority, or all, of projects. A majority still manually add specification references when modelling. However, 35% now manage their specification references digitally using a free plug-in from NBS.

When producing drawings or models, which of the following tools do you mainly use?



Autodesk	66%
Graphisoft	15%
Nemetscheck	9%
Other	5%
Bentley	3%
Trimble	2%

Within the projects you are involved in, do you coordinate project specifications with drawings/models...



22

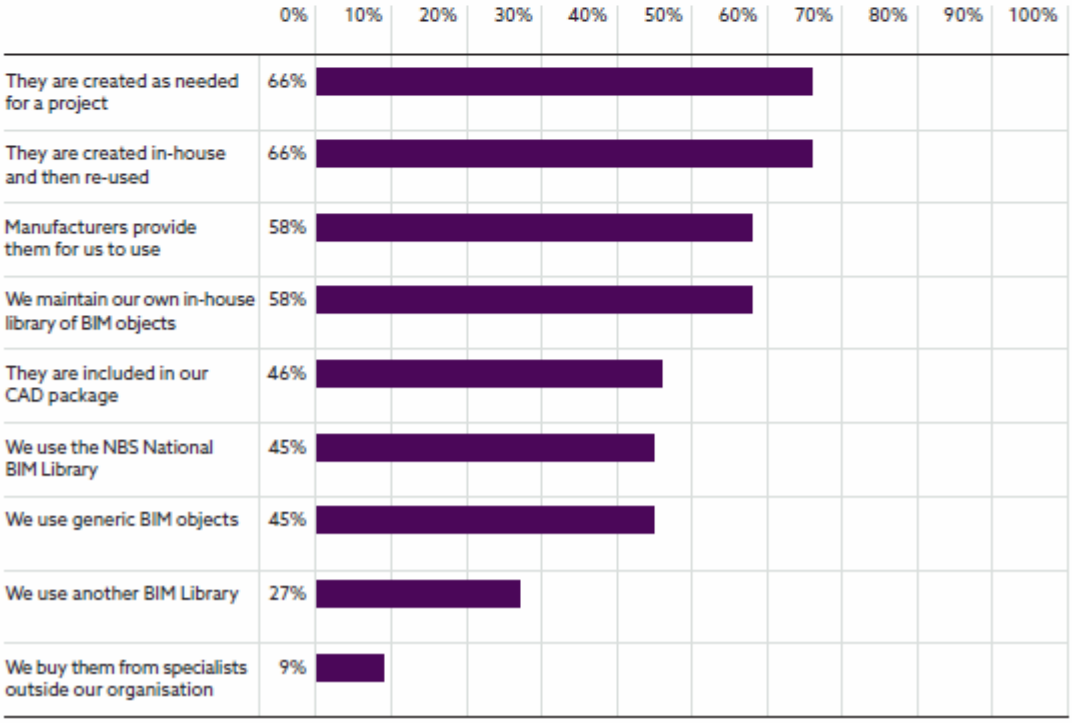
BIM objects

As more practices and projects are created using BIM, so the need grows for an ever broader range of objects with which to populate the models. Indeed, as models come to contain greater detail, the need for standardised, information-rich BIM objects increases.

The most popular ways of getting BIM objects is to create them as needed (66%), and to create them in-house, and then re-use them (66%). Other popular sources are objects provided by manufacturers, and maintaining an in-house library of BIM objects (presumably from multiple sources).

Any sourcing of objects that relies on re-use brings with it a degree of risk. Out-of-date information in a design threatens its realisation. Thorough checking of the information within objects to make sure that it is still accurate mitigates this risk. Even better is taking objects from an up-to-date, central, free-to-use library of information-rich BIM objects. Forty-five percent use such a library: the NBS National BIM Library. This is more than all other libraries combined.

Where do you get the BIM objects your organisation uses?



23

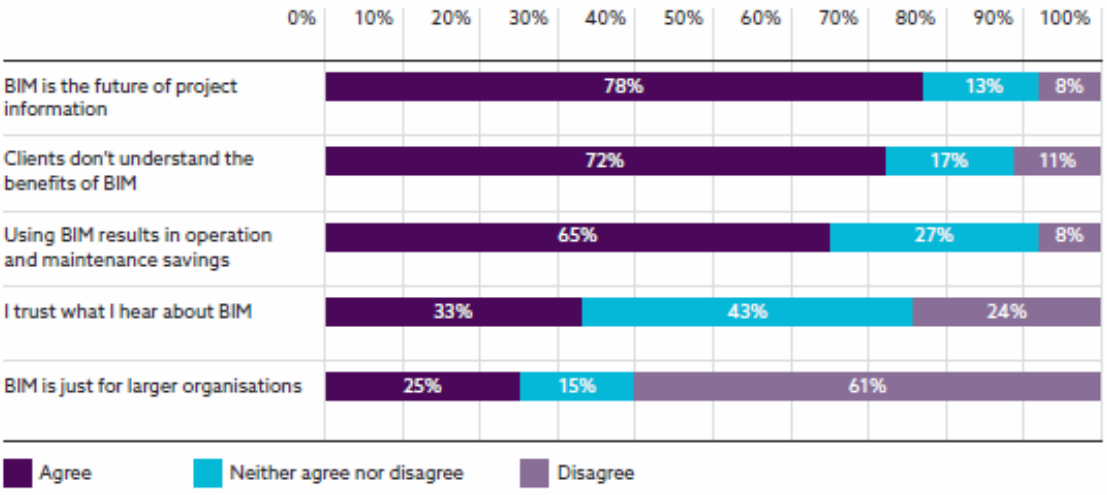
BIM experience

The future of the design process is BIM. Seventy-eight percent see it as the future of project information. In the years we have monitored its adoption, we have seen BIM become the norm for design practice.

The chart below outlines the next challenge. BIM has the capacity to bring real benefit beyond the design stages; 65% see that using BIM results in operational and maintenance savings, but 72% of clients don't understand the benefits of BIM.

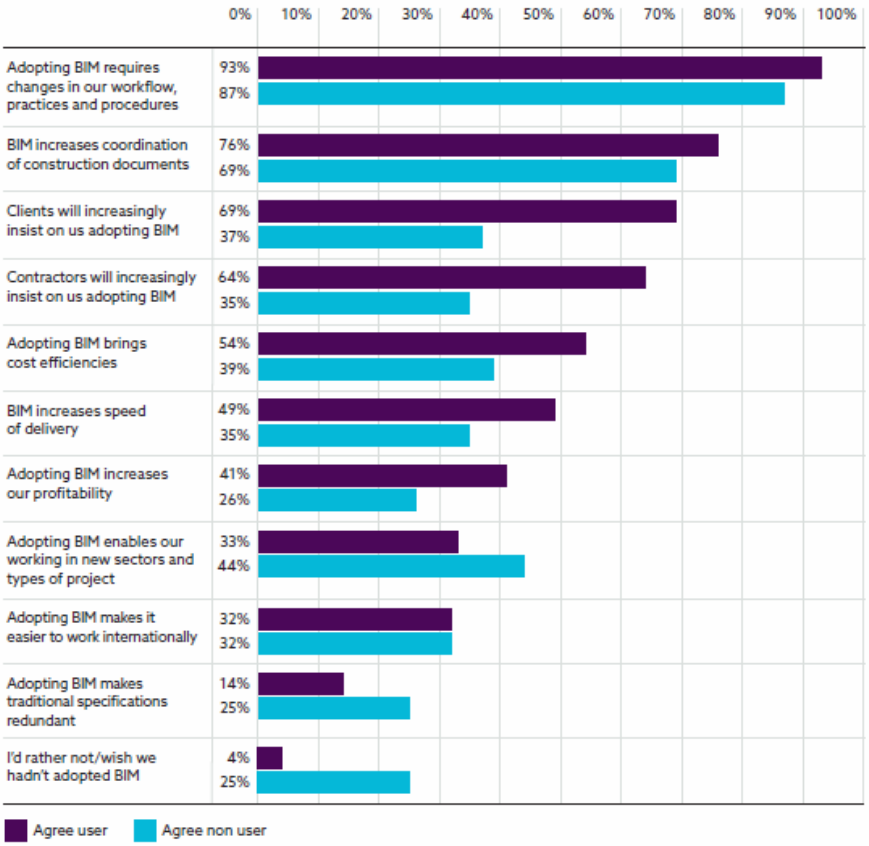
For the benefits of BIM to be more widely felt, there is a need for greater client education. Central Government is leading the way here, not least by outlining the cost savings that BIM has brought. These efficiencies need to become apparent, and to be demonstrated, to a wider range of clients. The move to BIM Level 3, in whatever form that ultimately takes, must help here.

Agreement with statements

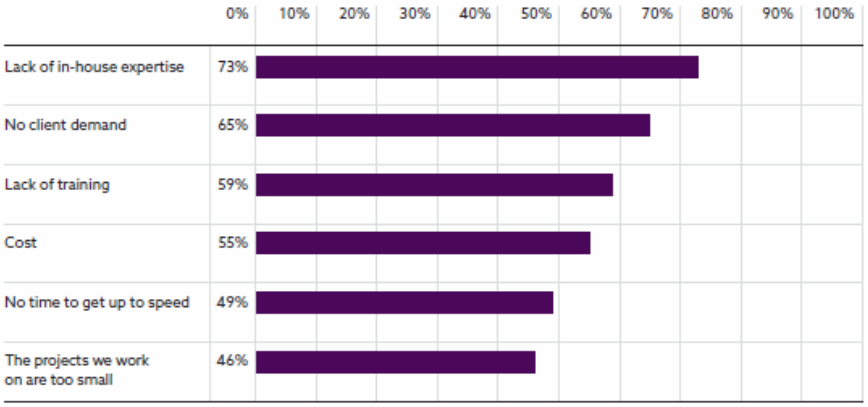


24

Do you agree or disagree with the following statements?



What are the main barriers to using BIM?



As in previous years, we looked at the views of those who have adopted BIM and compared them with those who have yet to start using it. This allows us to compare expectation with experience: experience is better than the expectation.

Adopting BIM is not easy. Over 90% of BIM users agree that it has required changes in their workflow, practices and procedures, yet only 4% wished that they hadn't adopted BIM (compared to a quarter of non-users who would 'rather not'). We can understand why so few regret adopting BIM when a majority see that BIM brings cost efficiencies, and that clients and contractors will increasingly insist on it.

We asked those who have yet to adopt BIM what the barriers to adoption are. These barriers fall into two types: internal, such as a lack of training, expertise, time or available funds to meet the cost of investment; and external, specifically a lack of client demand and projects being too small to require BIM.

Not using BIM may be sustainable in the short-term by restricting design work to those clients, contractors and projects where BIM is either not required or not appropriate. But that work may increasingly become a niche area.

End note

BIM adoption in the UK is growing in both extent (more people are using BIM) and in depth (people are moving up the BIM Levels). The introduction of the Government's BIM mandate has gone hand in hand with this. The BIM mandate has broadly been a success. There are areas for attention though, particularly in the education of clients and the enforcement of the mandate. In the longer term, there is a need for BIM to more fully move out of the design stages and into the maintenance of buildings.

Perhaps the significant changes of these last twelve months have been as important as the introduction of the BIM mandate.

In politics and economics, we are seeing era-defining change, through Brexit and the uncertainty that it brings across the design and construction sector.

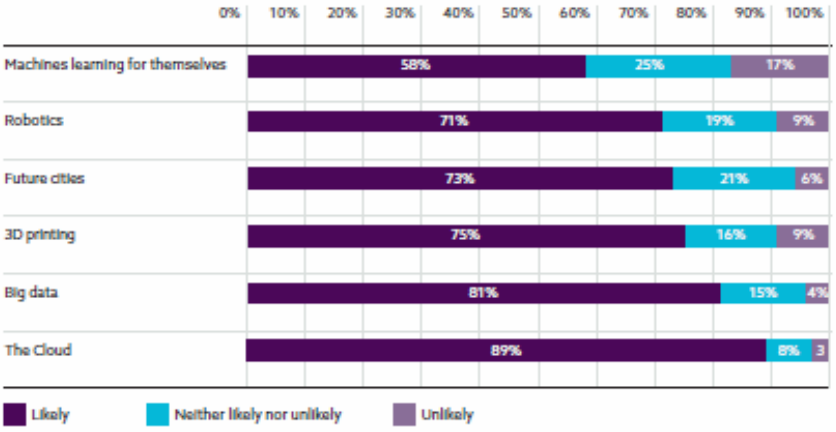
In technology, we see the rapid, at times astonishing, growth and development of data capture, exchange, aggregation and interrogation. Distinctions between consumers and producers of data are blurring rapidly. This is bringing new ways of working, and of working together.

Information is also changing how products are produced, whether they are apps, cars or jet engines. Real-time data capture and performance evaluation allows continuous design evolution. The value of a product is decreasingly held within the product itself, and increasingly in the data held about it. Unlike physical products, data can be reproduced and distributed at virtually no cost. This allows rapid collaborative improvements in design through the as-needed formation of disparate teams.

In such times of rapid change, new ways of working often flourish, and go on to displace old methods of production. We are seeing this with BIM, but BIM is likely just to be the start. The graph below suggests some of the developments that the design community anticipates next.

It is likely that these things will work together in ways that we don't foresee, but it's a safe bet that information-rich companies will flourish best.

In terms of the future of the construction industry, how likely are the following technologies to have a significant influence?



PRILOGA 9: Rezultati NBS mednarodne ankete 2013

NBS International BIM Report 2013

Adrian Malleson
Head of Research, Analysis and Forecasting, NBS

This section of the report draws together and compares the findings of the national surveys. The results show areas of similarity, but also some stark differences.

BIM usage and awareness

We asked whether people were aware of BIM. BIM awareness is high. We might almost say it's near universal. With 87% awareness, Finland has the lowest level of awareness. New Zealand has the highest at 98% with Canada and the UK not far behind. Where we have run the survey for consecutive years (in the UK and New Zealand) we also found that awareness is rising.

Unexpectedly, we didn't find a link between BIM awareness and BIM usage. Finland has the highest BIM usage at 65% but the lowest awareness at 87%.

The UK has the smallest number of those who tell us they are currently using BIM at 39%. Three out of the four countries have a majority who are now using BIM. Where we have run consecutive surveys, we can see that the numbers using BIM increase year on year.

We can expect BIM usage to continue to rise. BIM adoption has tripled in the UK over the three years we have run the UK survey.

Understanding of BIM

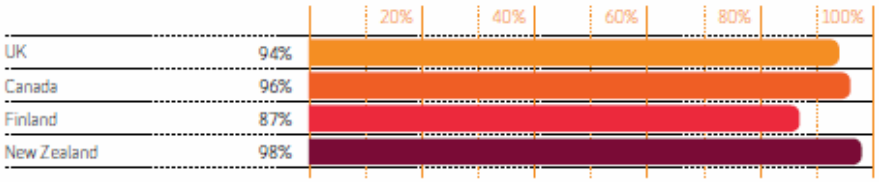
When looking at the national figures for BIM adoption, it's worth bearing in mind that the survey did not give a definition of BIM. This opens up the possibility that 'BIM' has come to mean different things, or to have different nuances of meaning, in different countries. We explored people's different feelings about BIM and we uncovered some national differences.

New Zealand construction professionals are more likely to equate BIM with 3D CAD and software. We would maintain this is mistaken. Whilst 3D CAD can provide geometric data, it does not provide the full rich data set a true Building Information Model requires.

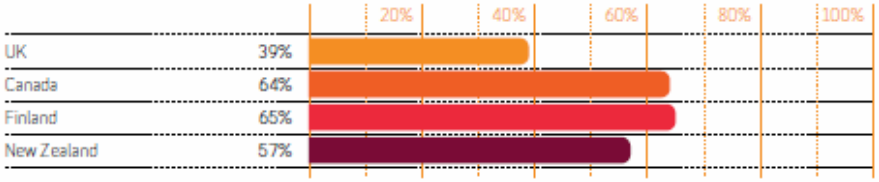
Attitudes towards BIM

The industry is not clear on what BIM is, according to those who have completed the survey. Perhaps this is related to an evident lack of trust about what people hear about BIM. Might it be that commercial organisations sometimes put their commercial interests before providing clear, dispassionate, descriptions of BIM?

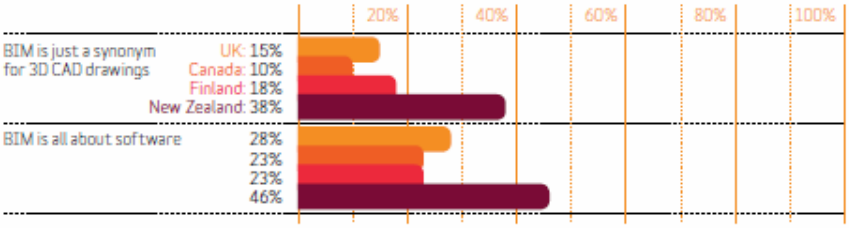
Awareness of BIM



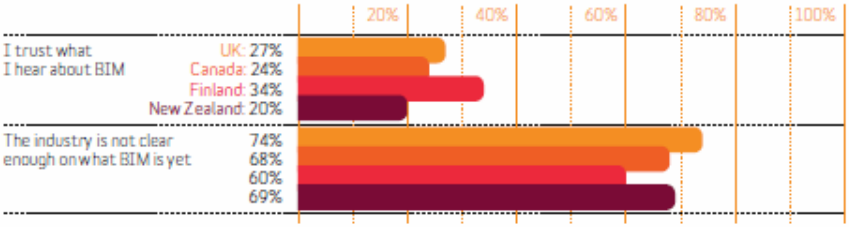
Respondents aware of and currently using BIM



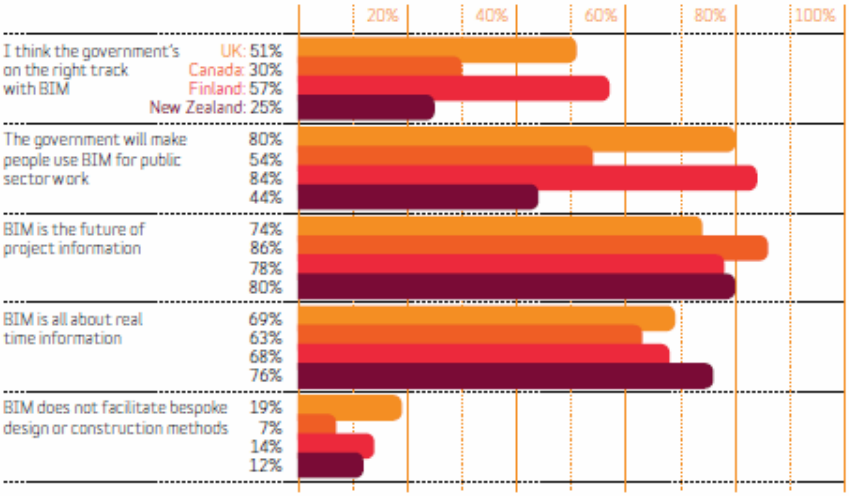
Agreement with statements...



Agreement with statements...



Agreement with statements...



We do see distinct differences about government direction between the countries and this falls into two camps. In the UK and Finland, a majority feel their government is on the right track with BIM. In Canada and New Zealand it's a minority (30% and 25% respectively). We can see that this coincides with whether a government will make people use BIM for public sector work. Where there is a feeling that the government will mandate BIM, there is also a feeling that the government is 'on the right track'.

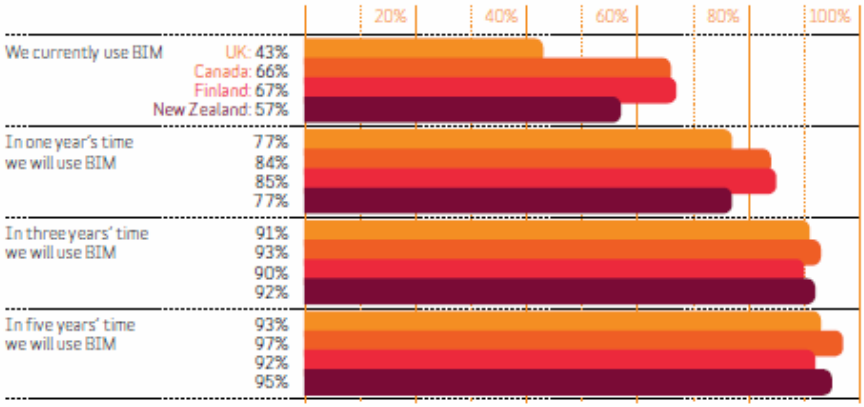
There is agreement that BIM is the future of project information, that it's about collaboration and that it doesn't stand in the way of bespoke design and construction.

Anticipated adoption reflects the belief that BIM is the future. We asked those who are aware of BIM whether they would be using it in the future. We found that whilst, overall, a majority use BIM now, in three to five years' time some use of BIM will be near universal. In every country, more than 90% of respondents expect to be using BIM within three years.

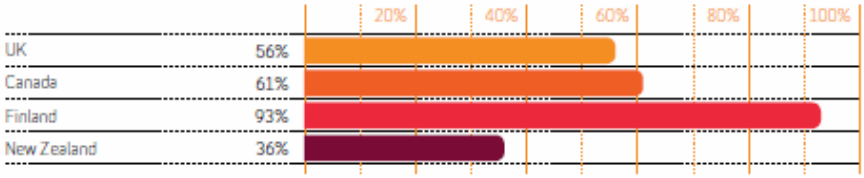
So, if the countries we have surveyed are indicative, we can expect that BIM will be required for international work in the medium term. Or, to put it another way, a failure to adopt BIM soon will mean an inability to work internationally in the medium term.

Having this level of international BIM adoption in a number of countries also makes clear the need for shared standards and the need for data to be freely exchanged between different applications.

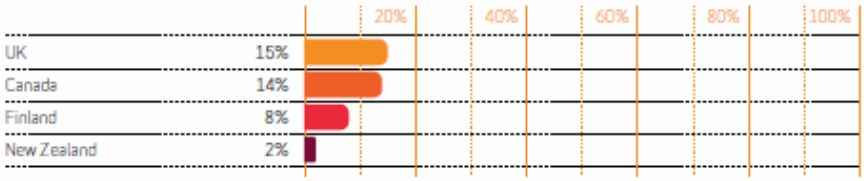
Future BIM adoption



Percentage of respondents who use IFC on their projects



Percentage of respondents who use COBie on their projects



IFC and COBie

The way in which Building Information Models can be shared across different proprietary software platforms is through Industry Foundation Classes (IFCs). This file format is vendor neutral and so allows models to be shared and worked on independently of any specific piece of software. This ability to have a standardised form of information exchange may become increasingly important for inter-country working.

We wanted to see if use of this file format is widespread. Firstly, it's worth noting that a significant number did not know whether they were using IFC formats, suggesting there is a need for greater communication here. Of those who did know whether they used IFC formats, we found some marked regional variations. In Finland we can see that almost all respondents (93%) use IFC on their projects. This compares with many fewer (36%) of those in New Zealand. A majority of those in the UK and Canada use IFC.

One of the main benefits of BIM is delivering cost reduction, not only in the design stage, but also in the operation and maintenance of a building through its life. And it is in a building's life that the bulk of the cost is incurred.

Construction Operations Building Information Exchange (COBie) data sets are a way of delivering part of a Building Information Model to assist in managing and maintaining a building.

We found that only a minority of respondents use COBie on their projects. The UK is the leader here, perhaps encouraged by UK Government policy. But even in the UK, only 15% use COBie on their projects. In New Zealand, it is only 2%. We do expect these numbers to increase over the years in all countries.

The BIM adoption process

Across the countries we surveyed, we can see that there is strong agreement that BIM is much more than purchasing and using a piece of software. BIM requires changes in workflow, practices and procedures. We might well expect this, given BIM requires collaboration and information sharing with others and involves maintaining a single, extendable set of information through a building's lifecycle. The data suggests these changes are worthwhile.

Whilst BIM requires change, and whilst change is often resisted, we can see that overall people are not resistant to BIM. Across the surveyed countries, only around a quarter of those who have not yet adopted BIM say they would rather not. More significantly perhaps, among users across the board, fewer that 10% say they wish they hadn't adopted BIM. This suggests that adopting BIM turns out better than people might have expected. This is encouraging.

End note

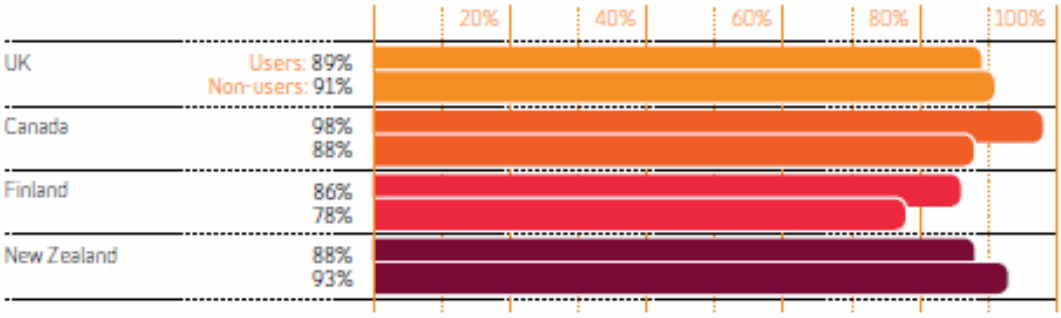
In this report, we've seen that there are some differences in attitudes towards BIM in different countries. There are different attitudes toward government action and some variance in what BIM is thought to be.

But there is more commonality than difference. In all countries, the professions see BIM as the future. We can expect an accelerating adoption rate. In three years, BIM will be the norm in all four countries.

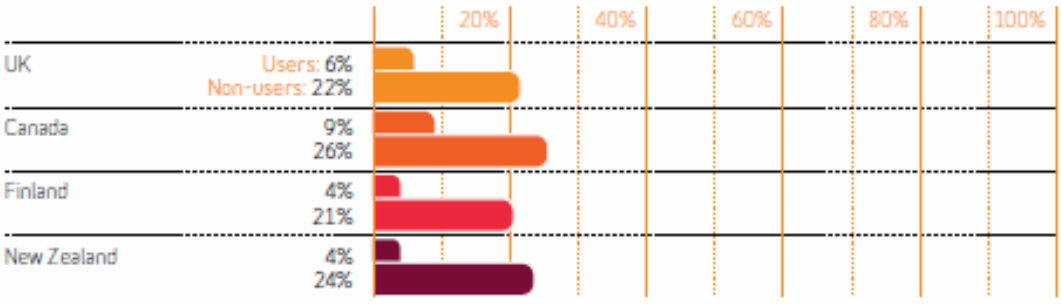
Those who are looking to adopt BIM tend to be positive about it. Those who have adopted BIM are even more so.

This is our first international view of BIM. We will be running our surveys again in 2014, and this will allow us to monitor trends. We invite other countries to join us.

BIM requires changes in our workflow, practices and procedures



I'd rather not adopt / I wish we hadn't adopted BIM



PRILOGA 10: Rezultati NBS mednarodne ankete 2016

NBS International BIM Report 2016

Adrian Malleson
Head of Research, Analysis and Forecasting, NBS

theNBS.com

The International picture

"BIM is the first truly global digital construction technology and will soon be deployed in every country in the world. It is a 'game changer' and we need to recognise that it is here to stay – but in common with all innovation this presents both risk and opportunity."

Patrick MacLeamy
Chief Executive Officer of HOK

In the UK, we have seen a significant increase in the numbers using BIM, and those who are using it tend to report positively on the advantages that it gives. These themes are explored in the NBS National BIM Report.

This report takes an international view. The construction industry is increasingly international, and growth is driven, at least in part, by increasingly sophisticated ways in which information is collaboratively gathered, aggregated, analysed and shared across and between countries. This is where BIM, used internationally, comes in.

Our joint report looks at international BIM through a selection of countries that are at different stages of BIM; it looks at current BIM adoption, the trajectory of change, and the assessment of risk and opportunity that each country sees.

Five countries worked together to gather the findings for this report: the UK, Canada, Denmark, Japan and the Czech Republic. All those who took part have a long history of working together to improve construction information for design professionals through the International Construction Information Society (ICIS).

BIM and the future

Throughout this report, we will see a range of data about BIM, its use and adoption. Before looking at the detail though, one figure is worth highlighting. In all countries, irrespective of BIM maturity, BIM is seen as the future of project information. In every country, more than three quarters of respondents agree that this is the case.

BIM is the future of project information

6

BIM usage and awareness

We asked whether people were aware of BIM. In all countries except one, awareness is over 90%, nearly universal. The exception is the Czech Republic: here awareness is at just over 50%, although we can expect this to rise rapidly, as we have seen in other countries.

BIM adoption is highest in Denmark, and lowest in the Czech Republic. Both Canada and Denmark report a majority using BIM on at least some projects in the previous year. In Japan and the UK, the figure is just under half. These figures suggest that BIM is increasingly becoming the norm for construction information across a range of countries. Indeed, adopting BIM may become a prerequisite for working overseas.

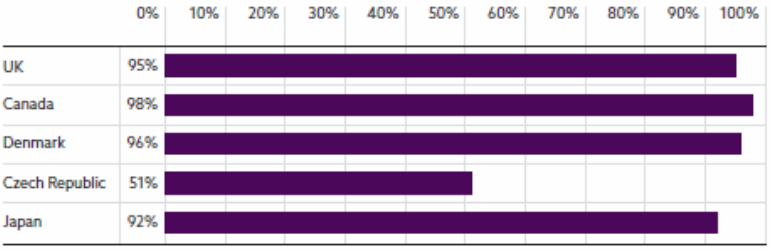
In the two countries that have taken part in this *and* the previous international survey, the UK and Canada, we can see an appreciable overall increase in the number of BIM users. The UK has moved from 39% in 2013 to 48%. Canada has moved from 64% to 67%.

We do need to apply some caution when viewing these figures, however. The figures given above are simply the percentage who tell us that they use BIM. As a country becomes more mature in BIM adoption, the criteria for describing oneself as practising it may become more demanding.

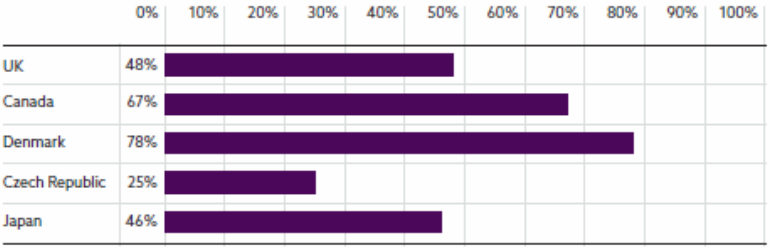
The survey did not give a definition of BIM, so it's quite possible that what people understand BIM to be varies somewhat by country. Whilst BIM is increasingly well described in international standards, we must allow for variance of understanding in different countries.

This is borne out by respondents' views about the clarity of BIM. The graph on the right illustrates, albeit with a significant degree of regional variation, that there is a feeling that the industry is not yet clear enough on BIM.

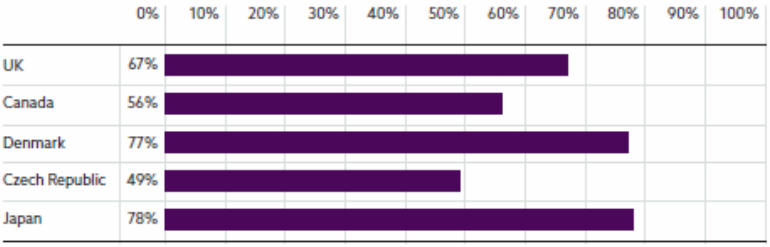
Awareness



Respondents aware of and currently using BIM



The industry is not yet clear enough on what BIM is

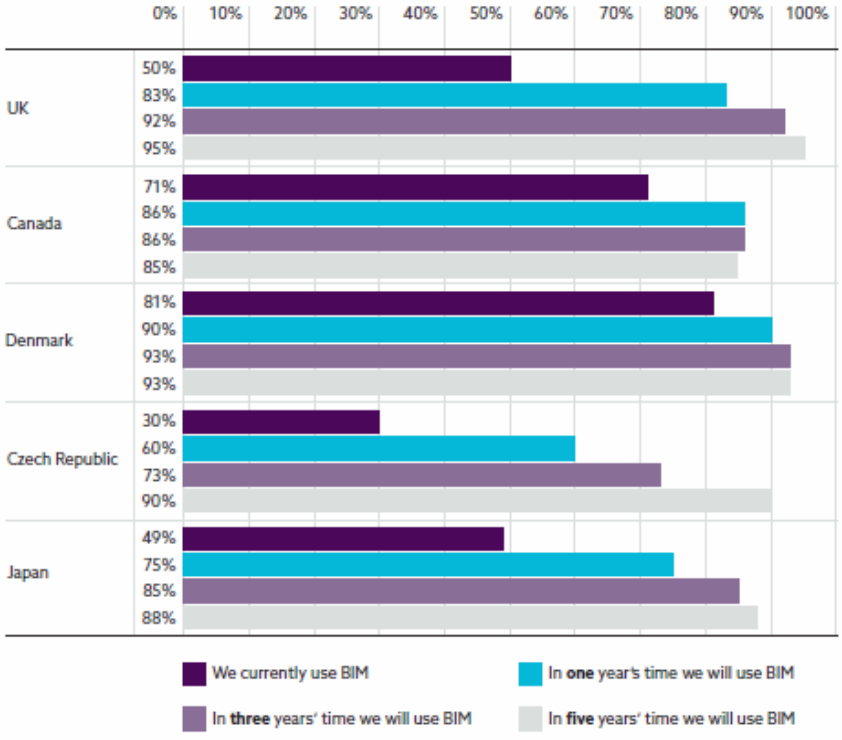


Future use of BIM

The trend of increased adoption is set to continue. We asked whether people would use BIM in the future. If people's intentions become professional practice, the next five years will see a very rapid transformation in how information about buildings is created, shared and used. Within five years, all countries expect BIM to be adopted by over 80% of design professionals. The next twelve months will see the most rapid rate of adoption.

Respondents from the Czech Republic take the most measured view, with the increments in adoption being the most evenly distributed across a five year period. In contrast, the UK, Canada and Denmark see the vast bulk of BIM adoption as happening within a three, or even one, year timeframe.

Future use of BIM



Understanding of BIM

Given the rise of BIM, it's worth spending a little time looking at people's understanding of what BIM is, what it isn't, and how people feel about BIM. There is a strong level of similarity across the countries we surveyed, but some significant differences too.

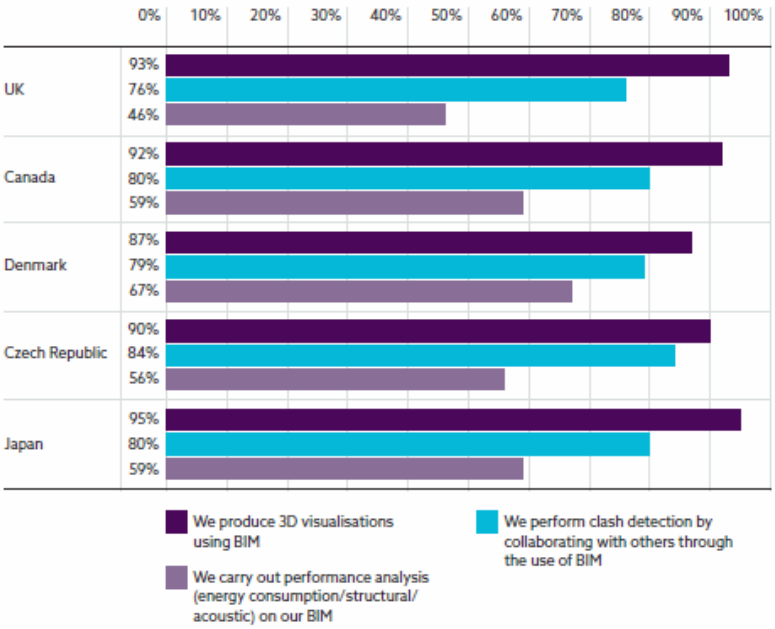
BIM has some immediate and real uses. BIM can readily be used to render accurate (and at times striking) 3D visualisations of projects.

Typically 90% or more are using BIM to produce 3D visualisations. Clash detection is used by more than three quarters of BIM users in all countries.

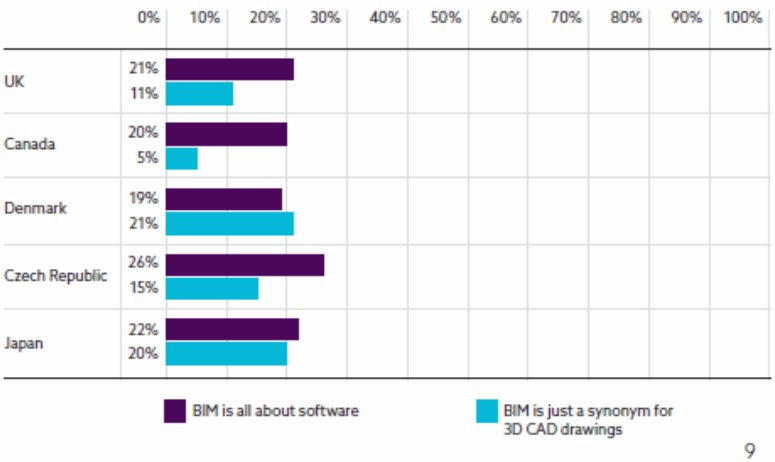
BIM also allows for more performance-based design practice, where performance analysis informs design decisions and product selection. Performance analysis is widely used, though less so than 3D visualisations and clash detection. Denmark is leading the way here, perhaps informed by its ambitious Climate and Energy Policy: the Danish Government's target is to reduce total Danish greenhouse gas emissions by 40% by 2020, compared with the 1990 level. Given that buildings account for 36% of EU greenhouse gas emissions, BIM can make a real contribution here.

BIM is described in many ways, but at heart it is a collaborative way of working, supported by software tools that make information about buildings available and analysable. We wanted to see if this view was shared, or whether people feel that BIM can be identified solely with software or 3D CAD. Across all countries, as the graph shows, it is a minority who feel that BIM can be reduced to a piece of software or a set of 3D CAD drawings.

Current use of BIM



BIM is...



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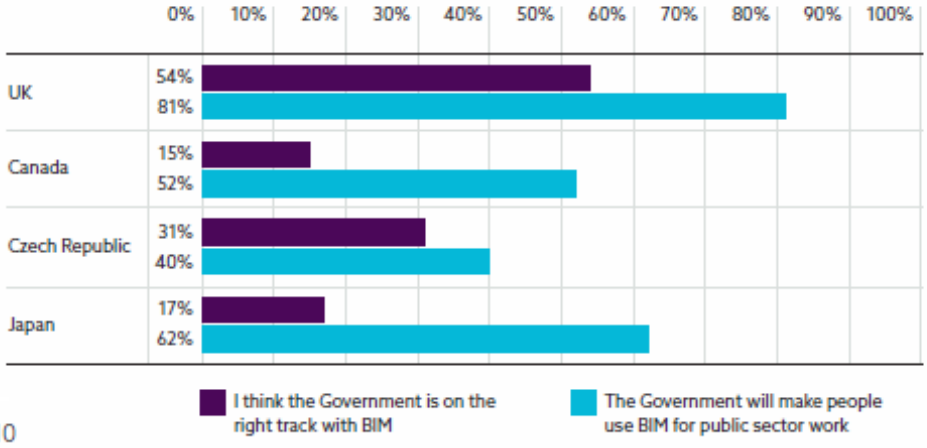
Attitudes towards governments and BIM

In the UK, as a part of the Government's Construction Strategy, the Government will require all centrally procured buildings to use BIM by 2016. Thus far, this requirement has been consistently held and communicated. We asked about people's attitude to their Government's approach to BIM. The UK scores the highest both for agreement that the Government is 'on the right track' and that BIM will be required for public sector work. This suggests that, in the UK at least, the design community is open to the Government taking a lead on BIM. This may be the case in other countries too.

Agreement with statements...



10

IFC and COBie

We have seen that BIM has been adopted in a range of countries, and that adoption will increase rapidly over the coming years. In principle, this will allow greater levels of international working and collaboration. But collaborative working across disciplines, teams and countries requires shared standards and the free exchange of data between different software tools.

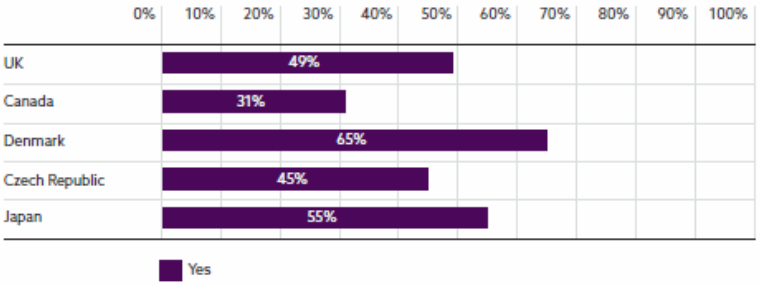
Industry Foundation Classes (IFCs) are there to allow this free exchange, albeit with some limitations. IFC is a vendor-neutral file format which allows models to be shared and worked on independently of any specific piece of software.

Denmark leads the way in IFC use, with 65% telling us that they have used IFCs on their projects. Around half of those in Japan (55%), the UK (49%) and the Czech Republic (45%) use IFCs. Canada has the lowest level of adoption, at 31%. In Canada, Japan and the UK, the number of those who don't know whether they use IFCs is notable, suggesting a greater need for communication about the importance of open file formats in collaborative working.

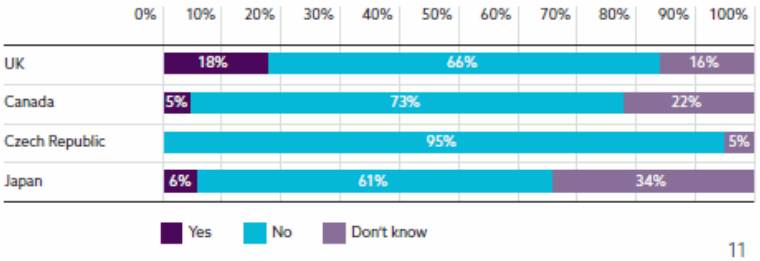
Our survey has concentrated on the use of BIM among the design team. We can see that BIM is delivering greater value and better ways of working for designers. But for BIM to fully realise its potential, it needs to inform not only the design and construction of a building, but also its use. It is in the operation and maintenance of a building that most cost is incurred. In principle, BIM can inform correct maintenance decisions, just as it does design decisions.

Construction Operations Building Information Exchange (COBie) datasets are a way of delivering part of a Building Information Model to assist in managing and maintaining a building. They are not widely used. The UK leads the way, but only with fewer than one in five generating COBie output. The data does not tell us whether this is an issue with the format itself, with procurement methods, or with current methods of asset management. In any case, delivering the value locked in a BIM to those maintaining a building remains an issue.

Do you use IFC on projects you've been involved with?



Do you generate COBie output for projects you've been involved with?



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The BIM adoption process

The decision on whether, and when, to adopt BIM is influenced by beliefs about how it will turn out, and what will be involved. But beliefs held in anticipation may differ from those held after the fact. We explored this by asking similar questions of both those who were using BIM and those who had not yet done so. We found some differences, and some close similarities.

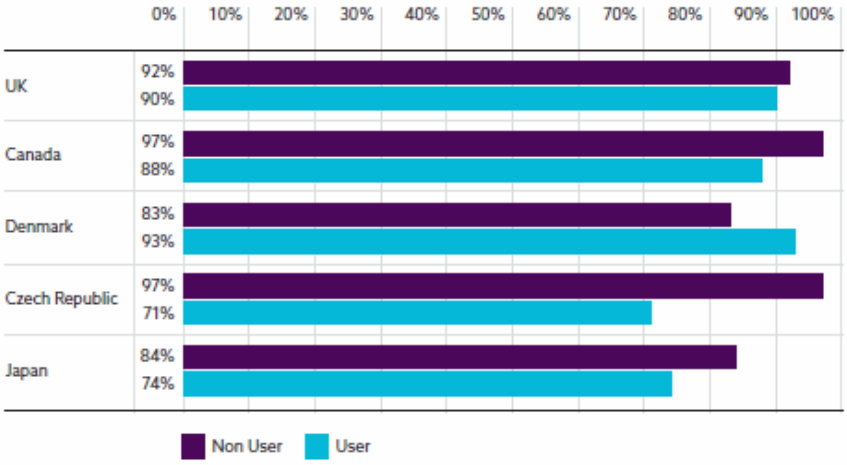
Given the benefits that BIM may offer, we might expect an upfront cost in changing the way in which design is practised. Across the countries, there is appreciation that adopting BIM is a process which demands change in workflow, practice and procedure. Both those who have adopted BIM and those who have yet to do so believe that BIM brings change (though *generally* those who have yet to adopt BIM are a shade more likely to anticipate change).

Current BIM users were more likely to tell us that both contractors and clients will increasingly insist on BIM. The graph on page 13 shows the high level of difference. In the UK, for example, less than a third of non-users anticipate an increasing contractor demand from BIM, whilst three quarters of users do.

We have seen the projections of BIM adoption This move towards BIM is broadly welcomed. Across all countries it is a small minority of non-users, fewer than a fifth, who tell us that they would rather not adopt BIM. In Denmark, it's less than 5%.

Encouragingly, *very* few of those who have adopted BIM tell us that they'd rather they hadn't. This is important because, ultimately, it is through design teams experiencing the benefits of BIM for themselves that BIM will become the norm for design practice.

Adopting BIM requires changes in our workflow, practices and procedures

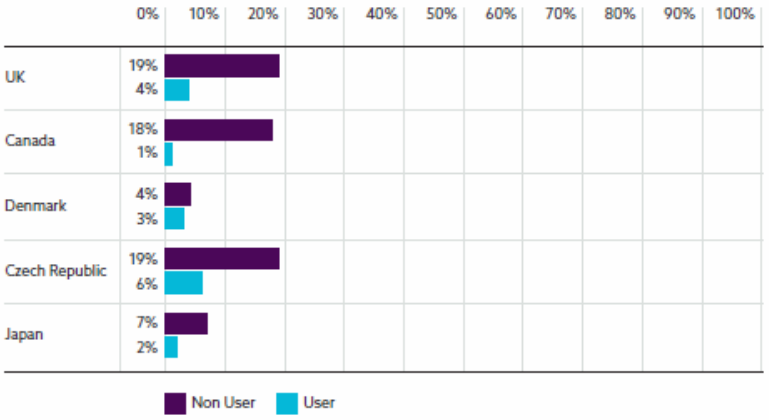


End note

This report has explored views about BIM in a range of countries. Whilst all these countries are mature economies with developed construction sectors, they are diverse in language, culture and design tradition. So whilst we can see differences between them, what is striking is the broad similarity in views about BIM. In all countries, BIM is seen as the future of design practice, and it's a future that is fast approaching. For most, BIM will become the norm within the next three years. BIM adoption is looked on positively by those yet to adopt BIM, and even more so by those who have done so.

The free flow of goods, services and *ideas* that we see in other sectors has been facilitated by the sharing of standard data. The findings of this report suggest that involvement in (and development of) the global construction industry will increasingly be dependent on BIM.

I'd rather not adopt/I wish we hadn't adopted BIM



Agreement with statements...