Developing a BIM Competency Framework

RESEARCH & KEY PRINCIPLES

SCOTTISH FUTURES TRUST

citb

CONSTRUCTION SCOTLAND INNOVATION CENTRE

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Foreword

In an industry of over three million people(*), where 95% work in SMEs, all actors need to understand the value of a digitally enabled industry. The UK BIM Alliance aims to lead, facilitate and focus this value proposition, so that our industry can operate efficiently, sustainably and productively in the 21st century.

The Alliance's aim of making BIM Level 2 'Business as Usual' can only be achieved successfully through the establishment of a digitally competent workforce involving members of the industry.

Competence is the application of a combination of abilities, skills, knowledge, behaviours and attitudes in activities at work. It is developed and assured not just through training, but through evaluation, support and assistance. Ultimately, professionals at all levels of the built environment need to be able to assess their current digital competence and be supported to develop additional competences(**) in terms of training and future experience.

The competencies required to deliver a digitally built Britain are still evolving. As such the educational and training landscape to develop the underlying skills and understanding, though well-intentioned, is disjointed with little standardisation. We support this report, produced by the Scottish Futures Trust (SFT), which highlights the need for the standardisation of competences. We further support the need to develop a standardised, useable and extensible framework which is open and can support multiple products and services. We recognise that the industry is formed from multiple stakeholders including individuals, teams and organisation, all of whom need to be able to manage capability, competence and capacity to deliver a digitally built Britain.

This report aligns with the aims of the UK BIM Alliance and we look forward to continuing to work closely with SFT and other stakeholders in helping our industry move towards a digital future.

Anne Kemp

Chair, UK BIM Alliance

(*) Transforming Infrastructure Performance, 2017, IPA

(**) We make no distinction between competence(ces) and competency(cies) as the latter is treated as a collective noun of the former

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- Paul Dodd, Associate Director, Scottish Futures Trust

Stakeholders & Consultees

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EXECUTIVE SUMMARY

Currently there is no standardised or up-to-date framework detailing the knowledge requirements or learning development needs of those who are involved in using BIM. This has resulted in widely differing understandings of BIM-related competency and skill requirements across education, training and professional bodies. To address this, the Scottish Futures Trust (SFT), working alongside the UK BIM Alliance (UKBIMA), led a consortium of stakeholders, including the Construction Industry Training Board (CITB), to investigate the benefits, challenges and proposed structure of a BIM Competency Framework.

The longer term objective of this project is to develop an easy to navigate, fully populated BIM competency framework resource, to support industry and academia to align curriculum, training and upskilling relating to BIM and digital collaboration, to a recognised, minimum standard of performance, knowledge and skills. The scope of this research project was developed to complement and align with other related work currently underway, particularly through the UK BIM Alliance.

A blended research methodology was adopted which included a review of published research as well as stakeholder workshops and user interviews. In addition, an overview and analysis of the current provision of BIM specific education and training in the UK, and Scotland specifically, was undertaken.

The research found strong alignment between stakeholders on the current challenges as well as the potential benefits of a BIM Competency Framework. Stakeholders believe that the lack of an overarching approach to competency management is resulting in highly variable quality and content in training and education delivery. This in turn makes it very challenging for businesses or individuals to assess the credibility and relevance of training options. The potential benefits of a single framework that stakeholders identified included:

- Increased overall confidence in BIM by making core and role-specific competencies accessible and transparent.
- Substantial efficiencies in time and resources for education and training delivery organisations.
- A common approach between organisations accrediting, funding, developing and delivering education and training in BIM.

The project included a high level review of existing competency systems, tools and frameworks for BIM and an evaluation of their potential applicability to this project. The frameworks reviewed included:

- The Learning Outcome Framework (2015)
- The BIM Academic Framework (2013)
- The BIMe initiative
- The National Occupational Standards for BIM,
- The BIM4VET initiative, and
- work currently underway within buildingSMART.

Much of this existing work was ground-breaking when it was developed and provides a useful starting point. However the research found that:

- Many are now out of date and haven't been maintained
- Some are for specific user groups and aren't suitable for wider application
- Some are internationally based and haven't been tested in the UK context
- Some have been adopted by specific users but do not have broader uptake.

The proposed framework

Based on the research, a set of recommendations have been developed on the principles by which a framework should be developed, its scope and the way it should be structured. A user profile for the framework was identified based on user interviews and stakeholder workshops. The two user groups are:

- Primary user group:
  - Organisations that develop, deliver, accredit or fund BIM training & education
- Secondary user group:
  - Employers, individuals and other stakeholders.

It is worth noting that the ultimate beneficiary of a BIM competency framework should be the individual through the primary users that develop, deliver and accredit training and education, applying the BIM competency framework within their curriculum and courses.

Principles:

- **Competency-based** – The framework should be based on the concept of competencies. It is proposed that the UK Government's defintion[i] is used: "Competencies are the skills, knowledge and behaviours that lead to a successful performance." These skills, knowledge and behaviour are required to deliver certain activities for successful performance. Activities are an inherent part of the proposed framework but not used as a primary structuring device.
- **Strongly aligned to UK BIM standards** – The competencies included in the framework should be those required by individuals to successfully design, construct, operate, manage and deconstruct buildings in a Level 2 BIM environment. It is recommended that the framework reflects the structure and terminology of the core suite BIM standards in the UK, in particular the BS and PAS 1192 standards and the BS 8536 standards. Consideration should also be made to changes to BIM standards with the publication of forthcoming ISO standards.
- **Simple and accessible** – It is recommended that the framework adopts a structure and terminology that is easily understandable, accessible online and is aligned to current industry models and approaches.

Scope:

- **Guidance not course content –** The framework will set out the specific competencies but should not provide course content or prescribe how to provide training for these competencies.
- **'BIM-specific' competencies** – The framework should only address BIM-specific competencies and not include generic industry competencies.
- **BIM only not "digital construction"** – It is recommended that the framework includes BIM-related competencies, rather than a broader range of digital skills that are part of 'digital construction'.

Structure:

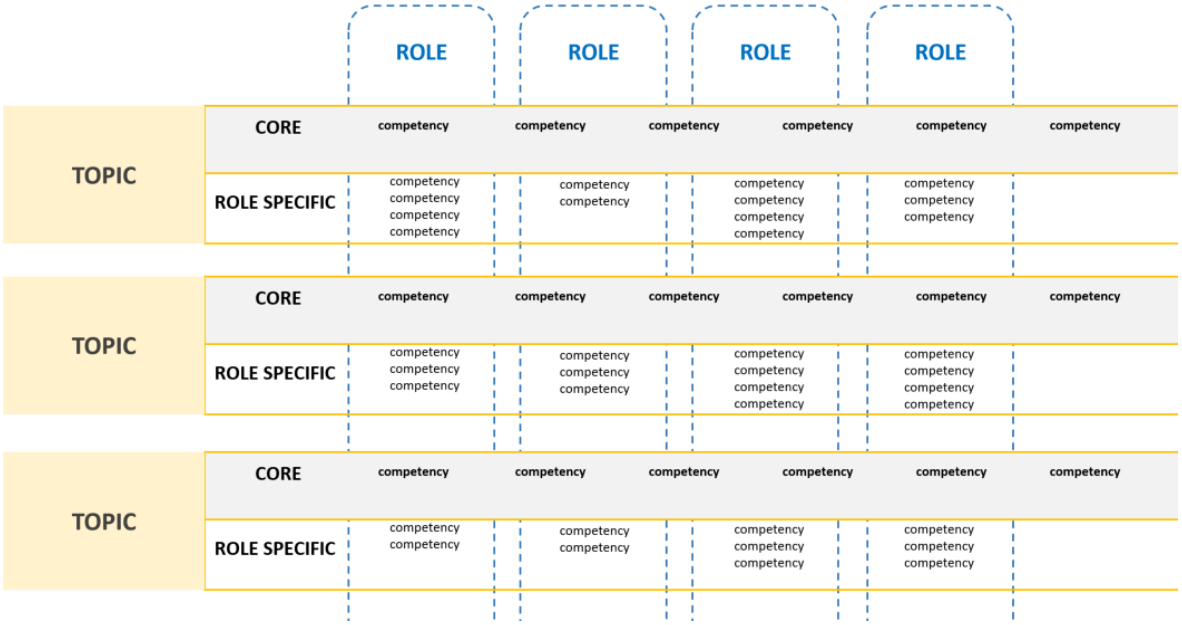
It is proposed that the framework is primarily structured by:

1. **Core and role-specific competencies**
2. **Topics**

In addition, it is also recommended that competencies are tagged with additional information and can be filtered according to:

3. **Competency type (Knowledge / Skills / Behaviours)**
4. **Stage in building life-cycle**
5. **BS & PAS Standard**

The diagram below outlines the recommended structure of a BIM competency framework which captures the principals, scope and structure listed above. (refer to section 6.0)



This research identifies a need for a BIM competency framework, that there is existing misaligned approaches within education and based on user engagement the key principles of any future BIM competency framework.

Moving forward, the recommendations of this research are not to define but inform and support the development of an accessible and considered BIM competency framework. By considering the recommendations made and the next steps listed in section 6.6, this will best enable the development of a framework that will support the upskilling of industry to implement and realise the benefits of BIM within the built environment.

1.0 PURPOSE AND BACKGROUND

1.1 Purpose

Currently there is no standardised or up-to-date framework detailing the knowledge requirements or learning development needs of those who are involved in using BIM. This has resulted in widely differing understandings of BIM-related competency and skill requirements across employers, education, training and professional bodies.

To address this, Scottish Futures Trust (SFT) led a consortium of stakeholders, including the Construction Industry Training Board (CITB), to investigate the benefits, challenges and proposed structure of a BIM Competency Framework. Construction Scotland Innovation Centre (CSIC) were commissioned to undertake the research. This report presents the findings and recommendations from this research.

1.2 Policy context

As the UK moves towards a digital built environment, the management of digital data and information is seen as a key mechanism to drive efficiencies during the design, construction and operational stages of buildings. The process to improve the management and use of data and information within the built environment is Building Information Modelling (BIM). BIM uses digital technology and collaborative working processes to improve the sharing and analysis of data within the design, construction and operational phases of the built environment.

The UK government's 2011 Construction Strategy embraced the use of BIM and mandated its use to maturity Level 2 on all centrally procured HM Government projects by 4th April 2016. The strategy highlighted its use as core to challenging existing industry business models and practices and driving greater collaboration, efficiency, innovation and value.[ii]

From April 2017, Scottish Government and relevant bodies in scope of the Scottish Public Finance Manual must adopt the new Scottish BIM Guidance for public works contracts commencing procurement procedures from 31st April 2017. Other bodies that can award public contracts, and other organisations providing delivery mechanisms for the construction of public buildings and infrastructure, are asked to implement BIM and integrate into their procurement procedures. In addition, the requirements for BIM may be included as a condition of funding for forthcoming Scottish Government infrastructure programmes[iii].

The Northern Ireland BIM policy is that from 1 April 2016, all Government centrally procured construction projects with a value greater than the EU procurement threshold for construction works shall, where there is potential for efficiency savings, be delivered to BIM Maturity Level 2. In Wales there is no explicit central BIM mandate[iv].

1.3 Aligned work

This project forms part of a wider set of initiatives across the UK, as well as internationally, to address BIM skills and training. The scope of the project was developed to complement and align with other related work currently underway, particularly within the UK BIM Alliance. As part of its upskilling workstream the UK BIM Alliance is supporting a project to assess the state of the nation with respect to training and competency in BIM/Digital within the built environment. The project is strategically focused and considers issues relating to the scale of the built environment sector and its workforce, how digital transformation will improve sector productivity and current progress on this journey, and the current status of competency and training in BIM/digital within the built environment.

The project is also intended to align with work currently underway within buildingSMART, the BIM Academic Forum (UK) and the BIM Academic Forum of Ireland (BAFI) who are developing a roadmap towards a longer-term vision of embedding BIM learning[v].

(Refer to page 44 for footnotes)

2.0 PROJECT METHODOLOGY

The project adopted a blended research methodology which included a review of published research as well as stakeholder workshops and user interviews. The approach explicitly draws on the principles of user-centred design which have been articulated elsewhere by many organisations[vi]. The key elements of a user-centred approach which were incorporated into the project's methodology are:

1. Identify the users of the framework, find out what they will use it for and in what context.
2. Identify what requirements or goals the users will have for the framework.
3. Review the current provision of BIM skills training and education in the UK, and Scotland specifically.
4. Create iterative framework structures as user needs are understood in more depth.
5. Evaluate the framework structure by testing with the user group.

The project sought to balance published material on the topic, from both academia and industry, with the views of key stakeholders. In part this was a necessity due to the small amount of published material on this specific area.

In addition a Project Board was established at the outset to provide guidance, oversight and feedback at key stages in the project. The Board included representatives from Scottish Futures Trust, the BIM Suppliers Group, CITB and the BIM for Academia Group.

"Comprehensive research on overall BIM competency is yet to be published."

Succar and Sher 2014

2.1 Research elements

The details of each element of the research methodology are set out in the table below.

1. Literature Search	A search for published articles and reports on BIM knowledge and competency was undertaken. As a result a total of 10 published reports and journal articles were identified and reviewed (refer to the bibliography). The budget and timeframes of the project did not allow a broader view of competency frameworks outside the built environment, however this could be undertaken at a future time.
2. Training & education landscape scanning	Drawing on work undertaken through the UK BIM Alliance, the current provision of both industry training and education sector training in BIM across the UK was mapped. In addition to this a detailed breakdown of all of Scotland's construction education system was developed to understand the scale and range of potential use of the BIM Competency Framework.
3. Stakeholder workshops	Two workshops were held with stakeholders: BIM Knowledge Framework Scoping Workshop 23 October 2017 Workshop participants included SFT, CITB, UK BIM Alliance, members of the BIM Public Sector Buyers Group, the BIM Suppliers Group and the BIM 4 Academia Group. A copy of the workshop summary report is available at bimportal.scottishfuturestrust.org.uk . BIM Knowledge Framework Scoping Workshop 14 December 2017 Workshop with members of the BIM for Academia Group to test proposed key principles and structure for the

	framework. Workshop participants included college representatives, SQA, ESP, university representatives, and Design, Engineer, Construct.
4. User & stakeholder interviews	A total of 12 interviews were undertaken including 7 with potential users of the Competency Framework and 5 with key stakeholders.
5. Analysis of other frameworks	A number of existing frameworks (or similar) were identified and reviewed. These included the UK BIM Learning Outcomes Framework, the BIM National Occupational Standards and the BIM Excellence Competency Table.
6. Iterative framework development & testing	The final research stage involved the development of a series of options for the framework's structure and scope. These were tested with the Project Board, and users, and refined based on their feedback.

3.0 CURRENT STATUS OF BIM EDUCATION AND TRAINING

The requirement for the development of a BIM Competency Framework is grounded upon the need for a supportive education and training model to achieve industry-wide digital transformation. The UK's BIM journey, which is ultimately underpinning this transformation, is firmly underway following the government mandates of 2016 and 2017 coming into force. This provides a timely opportunity to benchmark the current state of education and training, and to identify gaps in the existing provision of BIM upskilling opportunities.

This section aims to provide an overview and brief analysis of the current education and training landscape surrounding BIM to help demonstrate the requirement for the proposed BIM Competency Framework. The task of outlining the current state of BIM skills provision has been split into three key streams:

Stream One: Identifying the current provision of qualifications within the UK FE and HE education sector which have an explicit reference to BIM;

Stream Two: Identifying the current provision of industry training related to BIM upskilling; and

Stream Three: Mapping Scotland's construction education system to identify the range of potential users of the range and volume of potential users of the framework.

3.1 Stream One: Existing Provision of BIM-related Qualifications

BIM education, defined here as the provision of a BIM-specific qualification recognised in accordance with the national qualification frameworks, is still an emerging area. Therefore, to provide best value for our research, the scope of Stream One includes education across the whole of the UK. The remit of the search criteria was also restricted to secondary and tertiary education levels, i.e. courses provided within Further Education (FE) or Higher Education (HE) institutions, and did not include private training providers

	FE Institutions	**HE Institutions***
Scotland	26	18
England	275	135
Wales	14	9
Northern Ireland	6	4
Total	**321**	**166**

* Not including the Open University

BIM-specific qualifications by No

In total, the Higher Education Statistics Agency (HESA) lists 166 HE providers across the UK (167 including the Open University), whilst the Association of Colleges (AOC) lists 321 FE providers. Given the sheer number of institutions, keyword searches within a relevant database were chosen as the appropriate methodology to identify BIM-specific qualifications. To achieve this, the Universities and Colleges Admissions Service (UCAS) website was consulted.

The keywords used in the search of the UCAS website were "BIM", "Building Information Modelling", and "Building Information Management". Other iterations were attempted but returned the same results. To supplement this information, data drawn from guides to postgraduate studies published by the BIM Plus magazine was also used.

It is important to note that the results comprise only qualifications tagged with the identified keywords within the UCAS database; the returned results may be subject to missing information. For example, it is acknowledged that courses without explicit mention of these keywords in the title or course description will contain BIM content in their delivery material, such as through individual modules, but will not have been included in the results. The methodology adopted is intended to provide an indication of the existing state of provision at the time of writing.

The table below provides a snapshot of the collated results, omitting any duplicates and courses which are no longer provided.

Country	Course Provider	Qualification	Course Title
England	University of Salford	PgCert/PgDip/MSc	BIM and Digital Built Environments
Wales	Cardiff University	MSc	Building and Infrastructure Information Modelling (BIM) for Smart Engineering
England	University of Westminster	PgCert/PgDip/MSc	Building Information Management
England	University of Portsmouth	PgCert/MSc	Building Information Management
England	University of Liverpool	MSc	Building Information Modelling
England	University of Wolverhampton	PgCert	Building Information Modelling
England	University of the West of England	PgCert/PgDip/MSc	Building Information Modelling (BIM) in Design Construction and Operations
England	University of Derby	MSc	Building Information Modelling and Project Collaboration
England	University of Wolverhampton	MSc	Building Information Modelling for Integrated Construction
England	Middlesex University	PgCert/PgDip/MSc	Building Information Modelling Management
England	Oxford Brookes University	PgCert/PgDip/MSc	Building Information Modelling Management
N. Ire.	Queen's University Belfast	PgDip/MSc	Building Information Modelling Project Management
England	University of Derby	Uni. Dip	CAD and BIM (Architecture)
England	Northumbria University	MSc	Construction Project Management with BIM
England	University of Reading	MSc	Information Management for Design, Construction and Operation
England	Liverpool John Moores	MSc	Integrated Building Information Management
England	Cleveland College of Art and Design	HND	Practical Product and Spatial Design

The collated data is predominantly weighted towards the postgraduate end of the education sector, with all but one of the results being provided by a HE institution. According to these results, no postgraduate course yet exists in Scotland whilst most are provided in England (referring to the figures published by HESA, roughly 10% of English HE institutions provide a BIM-specific postgraduate degree). One course is provided in Northern Ireland and only one other in Wales.

However, it is unknown how often the UCAS database is updated to include new or recently developed courses which reflects a key weakness in this methodology. For example, work undertaken in Stream Three identified a PgCert/PgDip/MSc course being provided in Scotland by University of Strathclyde (*Advanced Construction Technologies & BIM*). Nevertheless, by undertaking these separate elements of work under each Stream according to their own methodology, the overall results provided by this section should produce a relatively reliable and robust state of Scottish provision.

The heavy focus on the later end of the education system is typical of the introduction of a government-led innovation; postgraduate degrees can be used as an intermediary tool for both those already in industry wishing to upskill and fresh graduates wishing to specialise, enabling lower level and traditional qualifications to implement change within their structures over a period.

In addition, more flexibility is generally granted in postgraduate studies as their standard 12-month format enables the provider to adapt their course year-on-year according to sector development. However, this also means the postgraduate landscape is vulnerable and heavily

reliant on demand. For example, six courses originally listed in the BIM Plus articles could not be found on the providers' websites, of which three were featured in the 2016 edition. Whilst we do not have the individual reasons behind these course closures, we can perhaps speculate that BIM education is not being used to its full potential as an upskilling device for both target audiences.

Popular or not, the delivery of BIM education is made redundant if content isn't being created to an agreed standard. Without interrogating each course provider individually, it is unclear as to whether any of the listed courses have been developed following a framework or syllabus, making it impossible to assess quality of courses for prospective students. The development of a BIM Competency Framework could therefore be used as quality assurance for courses already in existence, in addition to creating new courses and modules to an agreed standard.

3.2 Stream Two: Existing Provision of BIM Training

Introducing major innovation into the construction industry requires a significant shift in training provision to target those already qualified and working in today's sector. As such, the term *BIM training* in this section pertains to the provision of BIM-specific upskilling material which does not align to national qualification frameworks and is targeted towards those already in industry.

The task of benchmarking BIM training provision is more challenging than benchmarking BIM-specific education provision as there is no comprehensive database to draw on.Therefore the methodology underpinning Stream Two is basic and restricted to providing a generalised assessment of provision only.

As with Stream One, the focus of Stream Two includes the wider UK context. This approach has been chosen because BIM training largely comprises delivery formats which are not restricted by geographical location i.e. many of the resources are facilitated by web resources or can be hosted in-house. As Scotland has adopted the same standards for BIM delivery as the wider UK, training is not country-specific and is equally applicable cross-border.

A brief assessment based on internet searches reveals a rather complex and widely variable landscape of BIM training. Although most training provision seems to be geared towards providing Continued Professional Development (CPD) credits, the delivery formats vary significantly, as do credit weightings and suggested time allocation. Whilst the training landscape should cater to the various needs across an inherently diverse industry, there is a lack of quality assurance across these methods of delivery. This is in contrast to the standardised qualification-based structure of our education system which stipulates a certain level of knowledge should be provided at each level defined under the relevant National Qualification Frameworks.

However, as with the pitfalls in current education provision, individual training course content is also difficult to assess without either attending the courses or reaching out to the providers for more details. Given the commercial nature, the latter method is likely to prove difficult. However the following generalisations can be made:

- CPDs are either paid or free, and are weighted accordingly i.e. paid content provides more CPD credits/hours and vice versa
- CPDs can be delivered online, in-person, or in-house
- Courses seem to based strongly on the PAS 1192-2:2013 standard
- Certification for individuals or companies exist, although these are not formal qualifications
- There is currently no form of accreditation across providing bodies
- There doesn't seem to be accreditation or standard applied to course content across providers

3.3 Stream Three: Mapping Scotland's Construction Education

The third stream of this section is aimed primarily at supporting the use case for the development of the framework. The emergence of BIM-specific education and training is a short-term solution to upskilling those already based in industry. However, UK's current BIM journey should ideally culminate in BIM being organically woven into the traditional role-based model of our industry, which is fed into by our education system using a similar structure[1vii]. Therefore, Stream Three focuses on mapping the existing state of education for the built environment in Scotland and identifying the providers of these courses as potential users of the proposed framework. While Scotland provides a useful test-case, this exercise could be undertaken for the rest of the UK at a future date.

The Scottish qualification system follows a structured approach in which qualifications are mapped against the Scottish Credit and Qualifications Framework (SCQF). The qualifications are graded numerically from 1 to 12, ensuring a level of consistency is achieved across various qualification formats and learning programmes.

To achieve the remit of Stream Three, a database provided on the SCQF website (*http://scqf.org.uk/the-framework/search-database/*) was consulted to identify qualifications. The resultant list should be interpreted as indicative of the current state of Scottish-based education surrounding the built environment rather than exhaustive as a few qualifications aren't mapped.

The qualifications were obtained by filtering the database by subject area only, enabling results to show across all available SCQF levels and across all qualification providers. These were:

- Architecture, Planning and Construction, and
- Engineering

All results obtained with the former search criteria were included, whereas the results of the latter were accepted or rejected based on title as not all engineering subjects are directly relevant to the built environment, e.g. chemical engineering. Research degrees, either at Masters or PhD level, were also not included in this exercise.

A total of 597 courses were identified, varying from SCQF Level 3 to SCQF Level 11. A visual map of subject areas is provided in Appendix 1, in which the qualifications were grouped into broad disciplines by title (including a secondary discipline if required e.g. "Civil and Electrical Engineering") and mapped against the allocated SCQF Level. An excerpt from the detailed list of all qualifications, with information such as the type of qualification and the qualification owner, can be found in Appendix 2.

Key observations:

- The volume of courses and providers strongly supports the use case for the framework's development.
- Out of the 18 HE institutions in Scotland, two thirds provide a form of engineering degree relevant to the built environment.
- A huge variety of course titles existed for each subject area, including combined disciplines and different wording across provider.
- Only one course has explicit mention of BIM, which is also key to note as this was not returned within the exercise undertaken in Stream One.

3.4 Conclusion

Whenever a government-driven change in any industry is implemented, those already in industry and those who will form the future workforce are the two key areas of focus when addressing training and education needs. In the context of BIM, the former is being catered to by the creation of specific training by various commercial & non-commercial bodies and

postgraduate studies for professionals, whilst the latter will be affected by changes made to existing courses situated within the traditional role-based structure of the industry.

This section has highlighted an everchanging landscape of BIM-specific education provision which is heavily weighted towards postgraduate studies with no representation in Scotland. Postgraduate qualifications are a relatively quick solution for those already in industry and those emerging with lower level qualifications in the short-term. Likewise, a plethora of BIM training exist to upskill those in industry which is seemingly more effective at reaching practitioners than offering regulated qualifications as an alternative.

However, the growth and wide variety in non-regulated or BIM-specific education and training which has not been mapped to a framework, has led to growing concerns surrounding the measurement of competency and the lack of consistency in content. Both methods are redundant if the content being delivered is neither correct nor relevant to the UK or Scottish BIM strategies. This in turn, has consequences on the ability to integrate BIM content as business-as-usual within existing courses, a process which is much harder to benchmark without assessing every course and every module individually. Following the exercise carried out in Stream Three, we have also demonstrated that the built environment represents a significant area across the SCQF and across Scotland, ultimately illustrating the potential reach and impact of using a BIM Competency Framework.

4.0 THE USE CASE FOR A BIM COMPETENCY FRAMEWORK

This section sets out the proposed purpose of the BIM Competency Framework and addresses the potential users and their needs. The section concludes with a summary of the benefits and value case for developing the framework as well as some of the key challenges in doing so.

4.1 The purpose of a BIM Competency Framework

One element critical to achieving a digital transformation in the construction sector, is a dramatic increase in the level of BIM competence. This is unlikely to occur without a common understanding of the competencies needed across the range of roles and specialties involved in the design, construction and operation of the built environment in a BIM enabled age.

The overarching objective of this project is to develop an easy to navigate resource to support industry and those involved in designing training, educational and academic programmes, to align curriculum, training and upskilling relating to BIM and digital collaboration, to a recognised standard of performance, knowledge and skills. It is anticipated that a successful framework will:

1. Increase the standardisation of training and education in BIM.
2. Increase the consistency of training and education in BIM, and thereby support greater collaboration through shared knowledge and understanding.
3. Support greater uptake of BIM by aligning the understanding of competency between training and education providers and employers.
4. Support individuals to assess their current competence and identify appropriate training or education offerings to increase their competency.

> *"The industry really needs to examine what skills are actually needed for the new BIM paradiam."*
>
> **Shelbourn et.al. 2016**

4.2 Users of a BIM Competency Framework

One of the first steps in the research process was to identify and agree the potential users of the framework. The user profile was developed based on user interviews and stakeholder workshops, and tested with the Project Board.

As a result, it is proposed that the BIM Competency Framework is developed for two user groups: a primary group and a secondary group.

Primary user group:	Organisations that: ▪ develop ▪ deliver ▪ accredit ▪ fund BIM training & education	Including: ✓ Training providers ✓ Colleges ✓ Universities ✓ Professional Institutes ✓ Schools ✓ Accrediting / funding bodies ✓ Businesses developing in-house BIM training programmes for their staff
Secondary user group:	• Employers • Individuals • Others	✓ Employers seeking to understand skills gaps in their staff ✓ Employers seeking to identify appropriate training offerings ✓ Individuals wanting to evaluate their competency ✓ Individuals wanting to identify an appropriate training or education offering

The primary user group are those organisations primarily on the supply side of the BIM education & training system. The secondary user group mostly represent the demand side, however employers can also facilitate the supply of training.

The primary user group have the most influence over the outcomes this project is seeking to achieve and therefore are an appropriate key audience. While it is acknowledged that other groups may gain benefit from the framework, and indeed may use the framework with higher frequency, it has predominantly been designed to meet the needs of the primary user group.

"We would use it both for course design and for staff CPD and training."

College sector workshop participant

A further layer of consideration is that there are already two main groups receiving BIM-related training and education:

- those already working in industry
- the future workforce currently in the education system

Whilst these audiences may have different learning needs, the core competencies remain the same and should be accurate, relevant, and aligned with the national strategies surrounding BIM implementation.

4.3 The use case

During the research process, the potential users and stakeholders were engaged on the question of what they would use the framework for. During the interviews, potential users were asked a series of questions including:

- In what context would you use a framework?
- What tasks would you want to do on the framework?
- What would be your goal in using it? What would you be looking for?

The responses from both the interviews and the workshops are summarised below.

Organisation type		Goal / outcome of using the framework
Professional institutes	would use the framework to…	✓ "Stress-test" their current accreditation frameworks ✓ Map university courses to an agreed standard ✓ Determine gaps in current approach
Universities	would use the framework to…	✓ Develop new courses & programmes ✓ Do a gap analysis and develop a multi-year response plan ✓ Meet industry demand for new graduates' skills ✓ Enhance employability of students
Funding bodies	would use the framework to…	✓ Enhance quality assurance ✓ Increase standardisation ✓ Link it to grants or funding mechanisms
Colleges	would use the framework to…	✓ Identify staff CPD and training needs ✓ Increase quality of learning outcomes ✓ Support course design and delivery ✓ Promote their courses as being aligned to framework
Individuals	would use the framework to…	✓ Do like-for-like comparisons of training options ✓ Gain confidence in course selection
Businesses	would use the framework to…	✓ Evaluate the skills of their staff ✓ Assess training options

4.4 Current issues

Developing a Competency Framework for BIM with high levels of acceptance and functionality is a significant undertaking. It will require a substantial investment of time and resources from multiple organisations. Therefore it is important to carefully consider both the problem it is trying to address and the potential value and benefits.

This project is not attempting to assess either the broader benefits of BIM adoption or the range of barriers to increased uptake. It assumes the benefits of BIM which have been estimated in great depth by others are reliable.

Research undertaken by NBS in 2016 found that the majority of survey respondents are not confident in their BIM knowledge and skills. In particular:

- 23% describe themselves as being 'in between' confident and not confident in their knowledge and skills, and
- 28% describe themselves as 'not very' or 'not at all' confident in their knowledge and skills (NBS 2016).

The problem may manifest itself in professionals who lack confidence and skills, but is likely to be a symptom of a training and education system for BIM that faces numerous challenges. This was recognised by the BIM Academic Forum in 2013 who stated that "the increasing volume of output and information relating to BIM in industry and academia will lead to an additional challenge for the HEIs and the need for greater communication and collaboration between academics needs to be recognised" (BIM Academic Forum 2013).

Research undertaken in the UK in 2015 found that "the deployment issue of training and education of BIM remains largely unresolved and this is of increasing concern to employers and clients." (Bataw 2015). The same study, which focused on the civil engineering profession, found that "a large proportion of programmes have yet to address the integration of BIM and this could have implications for student recruitment, accreditation and employability" (Bataw 2015).

"BIM education is considered to be a solution to accelerate the BIM learning curve, thus providing companies with readymade BIM experts when students graduate."

Wu & Issa, 2014

These themes also emerged during the workshops and stakeholder interviews completed as part of this project and can be summarised as:

- There is no overarching approach to competency management in the area of BIM and as a result training is highly variable in quality and content.
- It is hard for businesses or individuals to evaluate the credibility and relevance of particular training offerings.
- Most BIM training delivered to date has been technology focused and has not adequately address issues of collaboration and information-flow. This in turn has driven attitudes and behaviours which many stakeholders believe are unhelpful to the longer term uptake of BIM.
- Most professional institutions are not well advanced regarding the integration of BIM competencies into their accreditation systems and do not have a clear policy on BIM competence

These challenges have international parallels with US research finding that educational institutions are being criticised for "their lack of strategies and capabilities to effectively introduce and leverage BIM into existing or future coursework" (Wu & Issa, 2014).

"the UK higher education institutions are increasingly being challenged to embrace BIM … but the supporting guidance is emergent and variable."

Bataw 2015

It is also more broadly part of the national digital skills challenge facing many sectors. Recent Scottish research found that 79% of Scottish employers expect the most significant issue of the future to be their ability to recruit people with the right technical skills or experience (Digital Scotland 2017). In addition, over half the employers want to provide more technical skills training to their staff.

4.5 The value and benefits

The desktop research, and user and stakeholder engagement, resulted in a strongly aligned view as to the potential benefits of an up-to-date and widely used Competency Framework for BIM. There was a shared view of the nature of the current problems and the role a framework would play in helping to address these issues.

At a fundamental level BIM adoption relies on a combination of people, technology and processes. If the people involved in BIM do not have the requisite competencies BIM adoption and success will be hampered. The education and training offered by the identified primary user group in this project (in addition to critical on-the-job training and experience) is one of factors that determines the level of BIM competency in the sector.

Therefore if those developing, delivering, funding or accrediting training and education in BIM have a common and agreed set of competencies, the quality, consistency and appropriateness of the training will increase. It is not the only element in improving the competency of the current and future workforce, but stakeholders identified it as a critical one.

Therefore the specific benefits that the framework will deliver are:

- ***Substantial time saving*** for the hundreds of organisations in Scotland involved in delivering education and training to the building & construction sector (identified in Section 4). It will provide a shared starting point for any organisation seeking to develop new training or update existing training.
- ***Increased overall confidence*** in BIM by making agreed competencies accessible and transparent. This will help greatly in addressing the perception of BIM as a 'dark art' known only to key experts.
- An ***agreed basis for engagement*** between those accrediting, funding, developing and delivering education and training in BIM.

"Identifying and then organising competencies will not only facilitate BIM adoption but will also clarify the complex activities undertaken during multidisciplinary collaboration"

Succar & Sher 2014

More broadly the framework has the potential to influence project delivery as well. Pioneering work by academics in Australia through the BIMe initiative has found that "standardising and thus clarifying how BIM competencies are defined and organised should contribute significantly to reducing inefficient interdependencies between teams and organisations" (Succar & Sher 2014).

A further benefit is that in the future standardised training materials could be developed to support individual learning outcomes. The training materials would be based directly on the suite of competencies drawn from the framework for particular user groups.

4.6 Key challenges

The problem the framework is trying to address, as well as its potential benefits, have been outlined above. However users and stakeholder also identified a number of challenges and potential issues that would need to be considered prior to embarking on the framework's development. The key issues relating to the development of a BIM Competency Framework are summarised below.

- **Developing a framework for multiple user groups**
  The users of the framework range from universities who may be seeking to develop advanced courses over a number of years focusing heavily on BIM, to training providers who may be developing short CPD courses which may be BIM-specific or more generalist. There was strong support for meeting the needs of a broad range of users, but acknowledgement that this made the project more complex and risked "pleasing no-one".

- **Striking a balance**
  The framework needs to strike the right balance between reflecting the complex and often technical nature of its subject matter, whilst being as accessible and user-friendly as possible. Research has noted that "implementing new technologies into a curriculum can be a difficult task especially technology as complex as BIM." (Bataw 2015) It is important that the framework enables, rather than creates, a further barrier to curriculum development.

- **Identifying competencies in a changing world**
  Many stakeholders recognised that BIM is changing the nature of the roles and competencies which the framework is trying to define. Some commented that the framework wouldn't be needed in 5 years' time when BIM is fully integrated into daily work practices. This means that it is a difficult balancing act between creating competencies around current roles, and redefining roles through the act of creating competencies. Ensuring the framework can be adapted and expanded over time will help address this.

"It is critical to address the skills issue (in BIM), as it will ultimately affect how roles are defined on a given project..."

De Cicco 2017

- **What do you mean by BIM?**
  Many stakeholders engaged in this project had reservations about the 'BIM' terminology. Some suggested that using different language such as 'information management' would better reflect the intended scope and address negative perception issues. Others felt that a much broader range of technologies were beginning to impact on the building and construction sector, and therefore the framework should not be limited to BIM. Examples included point cloud scanning, GIS, robotics, sensor technology, drone technology, etc.

- **All construction competencies or only "BIM" competencies**
  There were differing views amongst stakeholders as to whether the framework should map all competencies for built environment roles (we refer to this as 'generic competencies'), or should focus on competencies which are more specific to BIM (we refer to this as 'BIM competencies'). Many acknowledged that drawing a line between competencies which relate to BIM and those that don't is challenging when BIM assumes a fundamental transformation of all elements of building design, construction and operation.

- **Achieving compliance**
  The issue of whether there will be a compliance element to the framework was also raised by many stakeholders. There were a range of views here, with many believing that it should provide high level guidance and maximise flexibility to users. Others believed that the framework would have little impact without a mechanism whereby education and training offerings could be evaluated against the framework and those which meet the criteria could be allowed to communicate this to potential students.

5.0 EXISTING COMPETENCY FRAMEWORKS

There are a number of existing competency systems, tools and frameworks for BIM which were identified during the course of this project. This section provides a brief overview of these and concludes with an evaluation of their potential applicability to this project.

It is important to address the question of why there remains challenges with BIM education and training if these other frameworks exist. The answer to that will become apparent during the remainder of this section, and can be summarised as:

- Many frameworks are now out of date and haven't been maintained
- Some are for specific user groups and aren't suitable for wider use
- Some are internationally based and haven't been tested in the UK context
- Some have been adopted by specific users but do not have broader support.

5.1 Learning Outcomes Framework [associated with UK BIM Alliance]

Date:
2015 (initially released in 2012)

Purpose / users:
The goal of the BIM Learning Outcomes Framework (LOF) is to provide consistent information on Level 2 BIM to institutions, academia, training providers and private educators developing and delivering training courses to professionals in the sector[viii]. It was developed for:

- Public and private construction clients
- Professional Institutions
- Professional Training & Certification Providers
- Higher and Further Education Providers
- Technology vendors and service providers.

"When the Learning Outcomes Framework first came out in 2013 we reviewed all our courses against it and tweaked so that they aligned."

Training provider

Approach/structure:
It has 32 learning outcomes which are grouped under three headings as follows:

Topics (summarized into headings below)	**Learning outcomes** (examples only)
Strategic context	▪ Background and the need for collaborative working. ▪ The value of whole of life and whole estate approach rather than capital-led and single asset.
Organisation and implementation	▪ Implementation implications for the introduction of BIM level 2 on your organisation and supply chain. ▪ Organisational change management considerations in the context of the introduction of BIM level 2.
Information management and exchange	▪ The purposes of information in the capital and asset phases. ▪ Requirements for the exchange of information between supply chain members in a collaborative manner as described in PAS1192-2:2013 & PAS1192:3-2014.

The LOF does not provide training or course content. Rather it identifies the subject areas that should be considered for a common level of performance at Level 2 BIM. It states that the depth and breadth of the course objectives are dependent on the course or education level being taught, and that the manner in which they are delivered will be dependent on the facilitator.

Research findings:
Based on the user and stakeholder engagement undertaken for this project there appears to be widespread awareness of the LOF and a number of organisations have drawn on the framework to differing extents. However concerns have been raised by stakeholders about:

- the currency of the LOF and the lack of update since 2015 (De Cicco 2017)
- the lack of clarity regarding ownership and responsibility
- the lack of comprehensive adoption and
- the lack of monitoring in terms of adherence to the framework.

Location:
http://bim-level2.org/globalassets/pdfs/learning-outcomes-framework.pdf

5.2 BIM Academic Framework [BIM Academic Forum]

Date:
2013

Purpose / users:
The BIM Academic Forum (BAF) takes an earlier version of the Intended Learning Outcome Framework (2013), which broke down and established the potential learning outcomes requirements at levels 4-7 of higher education (HE), and applies a '*filter*' based on a series of professional roles/disciplines. The audience of the framework is specifically higher education institutions (HEIs). The stated intention is to provide a framework which is"non-prescriptive yet overarching...that can be configured and adopted for a wide variety of purposes that will allow HEIs to move forward quickly and confidently towards embedding BIM/digital Construction learning at the appropriate levels within 'discipline-specific' undergraduate and postgraduate education." (BIM Academic Forum, 2013).

Approach/structure:
The intended learning outcomes are focused in three areas, namely knowledge and understanding, practical skills, and practical skills at levels 4-7 of HE.. The intended learning outcomes have then been subsequently filtered in relation to roles/discipline HE programme/course, i.e. Architectural Technology, Construction Management, Civil/Structural Engineering, and Quantity/Building Surveying.

Note that the framework is not focused on developing competencies for each role, rather identifying the intended learning outcomes requirements in relation to the knowledge and understanding, practical skills, and practical skills for BIM/digital Construction learning at the appropriate levels within 'discipline-specific' undergraduate and postgraduate education at levels 4-7 of HE. Furthermore, it is currently focused on four roles/disciplines.

Research findings:

There was a mixed level of awareness of the BIM AF amongst users and stakeholders. The only copy readily available online is contained in the appendix to the BAF 2013 report and appears to be a screenshot from an excel file. The authors of this report were not able to obtain a copy of the file or a version of the framework beyond this report. No published research on the use of the BIM AF was found.

Location:
The report outlining the BIM AF can be found at:
https://www.heacademy.ac.uk/system/files/bim_june2013.pdf

5.3 BIM Excellence competency system [BIM Excellence initiative]

Date:

2017 (most recent iteration)

Purpose / users:

The BIMe Initiative is a not-for-profit knowledge generation and sharing effort undertaken by volunteer researchers from both industry and academia. The BIMe Initiative aims to improve the performance of individuals, organisations and project teams in the construction industry. It has a strong research base and appeared to be the only framework based on peer-reviewed and published academic research. It has a wide range of activities including:

- Developing a modular language for digital transformation
- Generating industry-wide competency benchmarks and identifying competency gaps
- Developing competency-based learning methods, tools and materials.

The BIMe competency system is integrated into the broader BIMe knowledge system and as such is connected to a multilingual BIM dictionary, the Model Uses list, and dynamically Defined Roles. Competency items are also used to assess organisational competency and to match team abilities to project requirements.

Approach/structure:

The BIM Competency Table [ix] is part of a multi-layered and interdependent programme of work. It is a strongly activity-focused approach which at its core identifies competency 'sets', 'topics' and then 'items'. These are not grouped by profession or role, however the intention is to provide additional filtering on this basis where appropriate. It should be noted that this sits within a broader 'Competency Hierachy' which includes: 3 Competency Tiers: Core Tier, Domain Tier and Execution Tier.

The table below provides examples from the Domain Tier:

Competency Sets (8 in total)	**Competency Topics** (56 in total – examples only included)	**Competency Items** (10s or 100s per topic are available but not yet publicly released – examples only are included)
Managerial	▪ General management ▪ Leadership ▪ Strategic planning ▪ Organization management ▪ Business development and client management ▪ Partnership and alliancing	▪ Defining and communicating overall managerial goals from adopting new systems and workflows. ▪ Identifying the organizational changes necessary for instigating, monitoring and improving BIM adoption. ▪ Initiating partnerships and alliances with other organisations based on BIM Deliverables and workflows.
Administration	▪ Administration, policies and procedures ▪ Financing, accounting and budgeting	▪ Developing managerial intiatives into policies and procedures to facilitate the adoption of BIM tools and workflows.
Functional	▪ Functional basics ▪ Collaboration	▪ Identifying the basic requirements and main deliverables expected form using BIM tools and workflows.
Operation	▪ General modelling ▪ Capturing and representing	▪ Using software tools to model project requirements and generate model-based deliverables across industries, information systems and knowledge domains.
Technical	▪ General IT ▪ Software Systems ▪ Model Management ▪ Document Management	▪ Installing, managing and maintaining general IT infrastructure.

	▪ Data Management	▪ Managing data flows – speed, volume, quality, and security - across project, asset, and information lifecycles
Implementation	▪ Implementation Fundamentals ▪ Component Development	▪ Identifying and managing issues associated with BIM implementation.
Supportive	▪ General IT Support ▪ Data and Network Support	▪ Troubleshooting software issues and supporting staff in resolving technical problems.
Research & development	▪ General Research & Development ▪ Strategy Development & Planning	▪ Conducting general or BIM-specific research and development activities.

Research findings:

Users and stakeholders were not specifically asked whether they were aware of the BIMe competency model or if they had used it. However many volunteered that they had knowledge of its existence and of those most were very positive about the approach and rigour. It was not clear how well stakeholders understood the system and the fact that Competency Items can be used in three different ways: as an ability; as an activity; and as a learning outcome. Some stakeholders noted that it may be a more useful system for individuals and businesses trying to assess their own competency.

Stakeholders also questioned how suitable the system is to the UK context. However the report authors were advised by BIMe Initiative that the system has been used to assess more than 60 companies in the UK alone, and used UK-specific Competency Items.

Location:

http://bimexcellence.org/resources/200series/201in/

5.4 National Occupational Standards for BIM [CITB]

Date:

2012

Purpose / users:

National Occupational Standards (NOS) are statements of the standards of performance individuals must achieve when carrying out functions in the workplace in their occupation, together with specifications of the underpinning knowledge and understanding. NOS are statements of effective performance which have been agreed by a representative sample of employers and other key stakeholders and approved by the UK NOS Panel. They are developed for employers by employers through the relevant Sector Skills Council or Standards Setting Organisation.

Approach/structure:

There are 62 NOS which relate to BIM. These were developed in 2012 by Construction Skills, the Sector Skills Council (SSC) for construction, prior to the current suite of BSI/PAS 1192 standards being released in 2013, 2014 and 2015. The 62 NOS are not grouped or structured in any way. Examples of NOS titles are:

- Specify project information and document requirements in a BIM environment
- Manage project completion and handover in a BIM environment
- Prepare performance specifications in a BIM Environment
- Prepare estimates of proposed capital costs in a BIM Environment.

All NOS are held on a searchable online database. However the search function is limited to a keyword search and the only tags relate to: who the NOS was developed by, which 'suite' (topic area) it belongs to and 'occupation'. The database is not very user-friendly – for example it's not possible to see a full list of suites or occupations by which to search.

An example of the structure and content in each 2-3 page NOS is set out below:

Area	Content
Title	**Develop a schedule of work in a Building Information Modelling environment**
Performance criteria (examples only)	▪ Collate project information and identify project needs ▪ Produce detailed schedule of works which are accurate, and contain a complete statement of the project needs and the range of services which will be needed
Knowledge & understanding (examples only)	▪ How to collate project information ▪ What to identify as project needs
Additional information (examples only)	▪ Conditions of contract ▪ Bills of quantities ▪ Specifications
Details	▪ Developed by ▪ Version no. ▪ Date approved ▪ Relevant occupations ▪ Suite ▪ Keywords

Research findings:
Few of the users and stakeholders engaged in the project were aware of the BIM NOS and even fewer had used them. This was attributed to several factors:

- NOS are primarily used to support those developing vocationally competent qualifications, which is a small subset of the framework's primary user group.
- The BIM NOS were developed prior to the current suite of BIM Level 2 standards and therefore their currency is questioned.
- They largely take an approach of adding the phrase "in a BIM environment" onto a 'generic competency' set and therefore are potentially not as helpful to guide the development of BIM-specific education and training offerings.

Location:
www.ukstandards.org.uk

5.5 BIM4VET (Standardized Vocation Education and Training from BIM in EU) [EU funded project]

Date:
2018

Purpose / users:
This is a research project which was initiated in 2017 to promote the coordination of BIM training offerings across the EU. The objective of the BIM4VET project is better alignment between "BIM qualification maturity assessment" and "BIM training offer in UE"
based on a dedicated digital information system.

Approach/structure:

The research method for BIM4VET was to:

- Define BIM roles based on the business tasks identified as well as the job offers available on the market. Four were identified and included in the project:
    - BIM Author
    - Senior BIM Author
    - BIM Coordinator
    - BIM Manager
- Define responsibilities associated with BIM profiles, weight their importance, and associate a subset of competencies taken from the BIMExcellence initiative
- Develop an inventory of BIM training offerings in Europe
- Design and prototype a toolkit which can
    - assess the competencies of individuals, and
    - support project teams to identify required competencies and highlight potential gaps in the team's skills.

During the application of BIM4VET to define a comprehensive, sector-wide, BIM training in Luxembourg, the responsibilities were reorganised to fit to the expectation of the stakeholders regarding the target groups to be trained (architects/engineers, contractors, etc).

Research findings:
Some of the stakeholders and users engaged in the project were aware of the BIM4VET initiative. A number expressed concern that the project had become focused on BIM-specific roles, rather than in a broader range of roles. However the authors were advised by the project team that although the definition of the BIM roles (that are called "profiles") was a first task undertaken in BIM4VET, the focus was on defining a set of 25 responsibilities that form a whole picture of the business tasks required to carry out a BIM-based project.

Location:
http://www.bim4vet.eu/en/results/deliverables/

5.6 Learning Outcomes Framework [BuildingSMART International]

Date:
Draft to be released early 2018

Purpose / users:
The goal of BuildingSMART is to be the leading neutral international forum for consensus building to support the creation, adoption and use of openBIM standards. It is an international initiative which also has local chapters, including a UK and Ireland chapter.

To date BuildingSMART's involvement in education and training has focused on a Professional Certification program which aims to provide a global benchmark for openBIM competency assessment. The buildingSMART Professional Certification program enables learning organisations to educate and certify individuals according to a recognised global learning framework.

BuildingSMART currently has a programme of work underway to develop a Learning Outcomes Framework (BS LOF) which defines the core components of the BuildingSMART International Professional Certificate Programme. The current intention is for organisations who wish their students to take the online test to pay a registration fee. Training providers that want their material approved against the framework would pay a charge for this level of assurance.

Approach/structure:
The BS LOF is being developed in two phases:

1. Core learning outcomes – this addresses the base knowledge required around BIM with around 25 knowledge & comprehension competencies which are core to all built environment professionals. The intention is that a basic understanding of the 25 competencies could be taught over a 2-4 day programme. This has drawn on the UK's 2015 Learning Outcomes Framework.

   In order to maintain consistency, the international content will remain the same across countries. However local chapters may add another section to reflect local knowledge and competencies. Both the international framework and the UK section are in final draft form.

2. Practitioner competencies – It is still to be determined whether this will take a role-based or an activity-based approach, however the authors understand that it likely to be structured around activities. No timeframe has been set for the completion of this work.

   This will utilise higher levels of learning (such as application and evaluation) to ensure that those developing against buildingSMART aligned content are capable in its application.

It is anticipated that there will be 8 core modules each of which has its own Learning Outcomes Framework, each containing 30-40 individual learning outcomes. Below is a summarised example of the 'Basic module':

Higher level learning aim	Individual Learning Outcomes (example)
To be comfortable with **what BIM is**, why it is needed, and its specific terminology	▪ Define the drivers that have led to BIM
To appreciate the **advantages** that BIM processes can bring compared to a traditional project	▪ Know why collaborative and new ways of working are required
To appreciate the need to plan **what outputs are required** to inform how information is produced, exchanged and maintained	▪ Know why employer's nmeed to clearly define their requirements (EIR)
To appreciate a need for an **open and interoperable** solution	▪ Define what BuildingSMART is
To be aware of your **team's capability** to working to the BM Process	▪ Know the benefits and challenges of adopting BIM
To appreciate **BIM Level 2** (UK)	▪ Define BIM Level 2

Research findings:
The research team was only made aware of this initiative towards the end of the research period. As a result users and stakeholders weren't asked about their knowledge or perspective on it.

Location:
Not yet available publicly.

5.7 Review of existing frameworks

The frameworks set out above have been reviewed in relation to their relevance and value to this project. It is important to note that the frameworks have been developed for a range of purposes and users, many of which are different to those of this project. Therefore the review is only intended to reflect the relevance to this project's aims, and not an evaluation of their overall merit of the framework.

Framework	Currency	Status	Could the framework be adopted	Limitations / Issues
LOF (UK)	2015	UK BIM Alliance currently considering updating	Potentially/partially – if updated	▪ Very high level – only 32 competencies ▪ Knowledge focus only, no skills Timing needs consideration.
BIM Academic Framework	2013	Currently being extended	Potentially/partially – if updated	▪ Updated framework only addresses 4 occupations
BIMe	Underway	Framework complete – set of competencies due for release in 2018	Potentially/partially – once completed	Options to either: ▪ Source competencies from the system/framework ▪ Partially align ▪ Adopt entire system/framework
NOS	2012	Stated indicative review date 2018	Potentially/partially – if updated	▪ Out of date ▪ Limited value regarding specific BIM competencies ▪ Address only part of scope
BIM4VET	2018	Almost complete	Unlikely in current form	▪ Only addresses 4 BIM-specific roles
buildingSMART	Underway	Still in development. Core competencies likely to be completed in 2018.	Potentially/partially – once completed	Options to either: ▪ Source competencies from framework ▪ Partially align ▪ Adopt entire framework Timing needs consideration.

This analysis demonstrates that much useful research and activity has been undertaken seeking to address the objectives of this research. However the consistency, collaboration and alignment of these activities has yet to be realised. In addition, all listed frameworks have either yet to be completed or require updating which suggests that any proposed BIM Competency Framework will require adequate funding and resources both to create and then manage this resource.

6.0 PROPOSED FRAMEWORK – PRINCIPLES, SCOPE & STRUCTURE

This section provides recommendations on the principles the framework should be based on it's scope and the way the framework should be structured. The recommended approach has been informed by user interviews, user and stakeholder workshops, and the guidance of the Project Board as well as findings from the literature search.

"We use the term competencies to integrate the granular notions of BIM knowledge, skills and experience"

Succar & Sher 2014

6.1 Principles

Three guiding principles are recommended to support the development of a fit-for-purpose framework which will meet its stated objectives. These are:

- **Competency-based** – The framework should be based on the concept of competencies. Competency is a broad term which includes concepts of knowledge, skills, abilities and behaviours. It is widely used across multiple sectors, including construction, and although

"there is no hard-and-fast definition of what competence is" (CITB 2104) it is recognised as appropriate terminology.

It is proposed that for the purposes of the BIM Competency Framework, the UK Government's defintion[x] is used:

> "Competencies are the **skills, knowledge and behaviours** that lead to a successful performance."

The research notes that "competence is not a binary notion – it is rarely either present or not present - but rather is located on a dimension modulated by different levels" (CITB 2014). However the purpose of the framework is not to evaluate an individual's progress towards full competency. Rather it is to define what full competency means. As such it is not recommended that levels of competence (e.g. basic, intermediate, advanced) be included in the framework.

- **Strongly aligned to BIM standards** – The competencies included in the framework should be those required by individuals to successfully design, construct,operate, manage and deconstruct buildings in a UK Level 2 BIM environment. It is recommended that the framework reflects the structure and terminology of the core suite BIM standards in the UK, in particular the BS and PAS 1192 standards and the BS 8536 standards (refer Appendix 3 for an overview of the existing standards). The BIM standards continue to evolve to reflect the transposing of BIM standards to the ISO standards and the development of further standards. Any framework should offer sufficient flexibility, extendability and resource to maintain alignment to current and future standards.
- **Simple and accessible** – BIM by its nature is a complex area and can be inaccessible to those at the start of their learning journey. It is recommended that the framework adopts a structure and terminology that is easily understandable, simple to access and navigate, and aligned to current industry models and approaches.

"An individual's competency cannot always be designated through a binary proposition (i.e. competent / incompetent) but may be better described as a continuum..."

Succar & Sher 2014

6.2 Scope

The proposed scope of the framework is set out below:

- **Course guidance not content** – The framework will set out the specific competencies but will not provide course content orprescription on how to train in the competencies. These matters should be left to the training developers and providers to determine and will be influenced by their market, etc. However where possible the framework should include guidance on how to determine if a competency can be demonstrated. Also the competencies will reference the approach section or requirement within the UK BIM Level 2 standards or documents.
- **'BIM-specific' competencies** – As a high level principle, the framework should only address BIM-specific competencies and not include generic industry competencies. This recommendation is based on two considerations:
    - Practicality - the breadth of a framework for the entire built environment sector is a very significant undertaking and would take a long time and a high level of resourcing to deliver.
    - Mandate – to develop a generic framework would require the specific mandate and support of a much larger range of stakeholder organisations.

  It is acknowledged that drawing a line between 'generic competencies' and 'BIM-specific competencies' is a difficult task. The following guiding principle is recommended: the framework will focus on and prioritise competencies that are most different when working in a BIM environment as opposed to a traditional environment and those competencies that are most critical to driving forward progress in BIM Level 2. This should align with the BIM standards being implemented within the UK.

- **BIM only not "digital construction"** – It is recommended that the framework includes BIM-related competencies, rather than a broader range of digital skills that sit around the edges of BIM. For example competencies that relate to point cloud scanning, GIS, robotics, DfMA etc should not be included.

In many areas, opportunities were identified for a phased approach to the framework's development. For example, several areas for supplementary information were identified and it is proposed that these are delivered in a phased manner.

6.3 Structure

All competency frameworks organise competencies using one or more key structuring devices. These devices allow the content to be accessed in different ways. Examples of structuring devices include: by topic/area (based on specific content), role/profession, level of knowledge, type of competency (skills, knowledge, attributes, etc).

Providing access to the BIM Competency Framework through an online platform enables multiple structuring devices to be used, whilst still achieving a simple and accessible user experience. This can be achieved through filtering, search options, tagging and other sorting methods.

Based on the research undertaken for this project it is recommended that the two core parts to the structure of the framework:

- **Core competency and role-specific competency**
- **Competency topics**

"Professionals within the AEC industry…suggest that the teaching required for BIM should focus on the core concepts rather than the application interface and functionalities."

Bataw 2015

Core competencies and role-specific competencies

Stakeholders engaged in the project identified a "T-shaped" approach to competency. Under this model there are shared competencies which are required by all those operating in a BIM Level 2 environment, regardless of their role – this forms the horizontal bar of the "T". The vertical bar represents the competencies which are specific to each role in a project team. A fully competent individual is considered to be someone who possesses all the core competencies as well as their role-specific competencies.

Core competencies:

- are the personal traits, professional knowledge and technical abilities **required by all** those undertaking the range of roles included in the framework.
- will be more strongly focused on **knowledge based** competency.

Role competencies:

- are defined as the personal traits, professional knowledge and technical abilities **required by those undertaking each specific role** included in the framework.
- will be more strongly focused on the specific **skills and behaviour competencies** required for each role.

Roles to include in framework

The purpose of this research has been to develop and test a structure for the framework rather than populate the framework. As such the roles set out below are a recommended starting point for the population of the framework, rather than exclusive list of roles to be included.

The NBS BIM Toolkit was used as a starting point for identifying roles, with further testing and input by users and stakeholders. It is recommended that the framework is developed in such a way as to allow more roles to be included in a flexible and dynamic way. It is anticipated that as various trade and professional bodies become engaged in the BIM Competency Framework, they could lead the development of 'role competencies' for the roles they cover.

The roles used to test the framework structure were:

1. Client / procurement role
2. Architectural role
3. Project management role
4. Quantity surveying / cost control role
5. Engineering roles (services, civil and structural)
6. Construction management role
7. Facilities management role
8. BIM information manager role

These roles (and others in the future) should form the x axis of the framework.

Discussion

Existing competency frameworks cluster competencies in different ways. Some begin with a "bottom up" approach identifying individual activities that must be undertaken across a whole building lifecycle, and then tend to cluster these into functions. Others begin with a "top down" approach identifying specific professions and then clustering competencies which are typically undertaken by this profession.

These can be illustrated as a range on a spectrum as shown on the diagram below. The approach recommended here is to cluster competencies according to the key roles undertaken in a project. For example someone who is undertaking a project management role in a project will need a certain cluster of competencies. This person may be qualified as an architect, but is not undertaking an architectural role in the project.

The benefit of this approach is that it balances the flexibility of the activity based approach, with the need to provide helpful guidance to those developing education and training offering for those in specific disciplines. It is considered an appropriate response for the current state of the sector, and is part of a transition point away from the more traditionally siloed nature of the construction industry.

Competency Topics

In addition to structuring the competencies by core and role-specific groupings, it is also recommended that they are clustered into topics. These topics will be drawn from the core suite of standards as well as industry best practice documents. For the purposes of testing the proposed framework, the following topics were identified:

- Collaboration & Common Data Environment (CDE)
- Documentation & information delivery
- Value, benefit & investment
- Data management
- Tools & technologies
- Standard methods & procedures
- Roles & responsibilities
- Capability & assessment
- Asset information
- Contracts
- Security
- People & technology

These Topic should form the Y axis of the framework. Under each topic there will be a set of core competencies and sets of role-specific competencies for each role. It is anticipated that some role-specific competencies will be repeated across more than one role. No specific number of competencies per topic is recommended, however the testing identified that there may be around:

- 30-50 core competencies in total (1-5 per topic)
- 20-30 role-specific competencies in total per role (1-3 per topic)

This would result in each role having a total of 50-80 competencies (core plus role-specific).

6.4 Filtering options

In addition to the main structuring elements of the framework it is recommended that competencies are tagged with additional information to allow users to search in different ways. Three additional filters are recommended as follows.

- **FILTERED BY: Competency type (Skills / Knowledge / Behaviour)**

  Each competency should be classified as either a skill-based competency, a knowledge-based competency or a behaviour-based competency. Skill-based competency refers to the ability to undertake a specific activity or task. Knowledge-based competency refers to having an understanding of a particular subject or issue. Behaviour-based competency refers to the ability to act or behave in a way conducive to effective performance. These could be developed based on scenarios or industry case studies, and may be a channel to develop strong industry engagement with the framework.

- **FILTERED BY: Stage in Building Lifecycle**

  It is also recommended that users can filter the competencies based on the stage of the project delivery cycle. Some competencies will relate strongly to the initial stages of a build project, whereas others relate to the later phases or the operational phase. Although the research suggested this shouldn't be a primary structuring device, it is anticipated that through 'tagging' this could provide some added benefit to users.

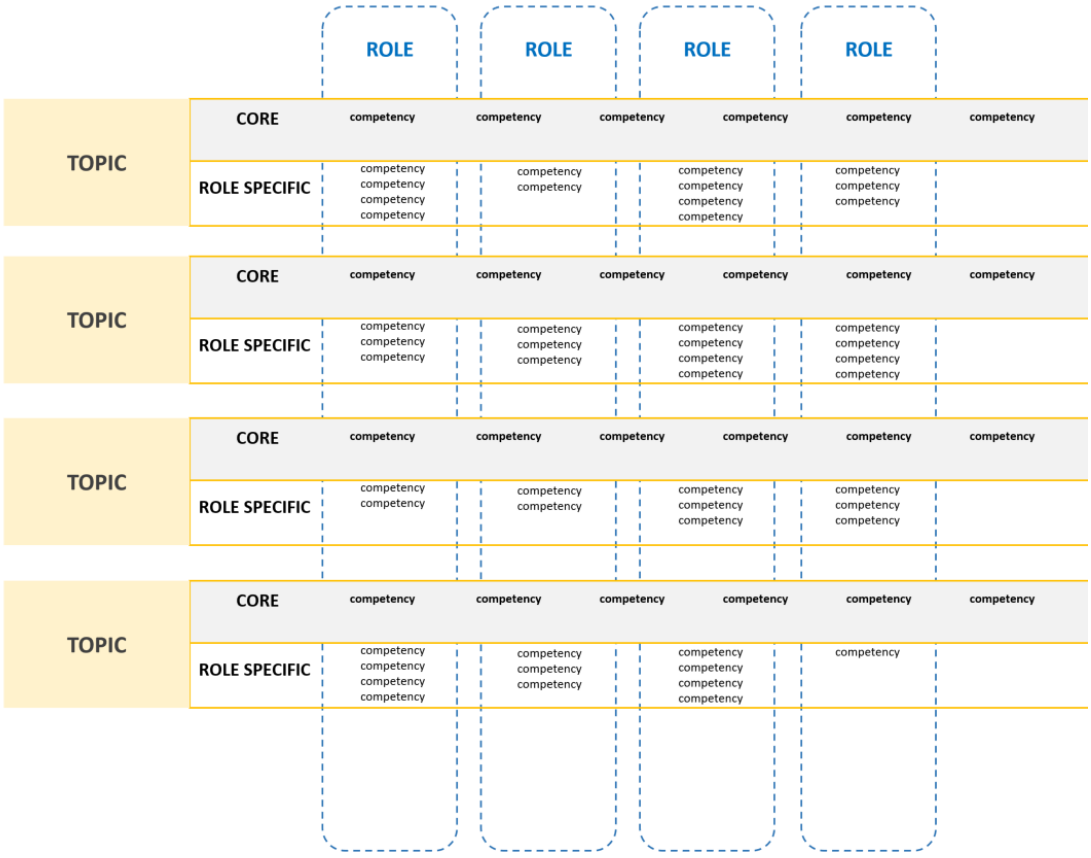
- **FILTERED BY: BS & PAS Standard**

  It is recommended that where a competency has a direct connection to one of the core suite of standards, this information is tagged to the competency. Competencies may be relevant to more than one standard, or more than one location within a standard, and so multiple tags may be required.

6.5 The proposed framework

The proposed structure for the framework is illustrated in the graphic below. Across the top (x axis) are the roles and down the left hand side (y axis) are the topics. For each topic there are both core competencies, which are relevant to all roles, and role-specific competencies.

Framework structure

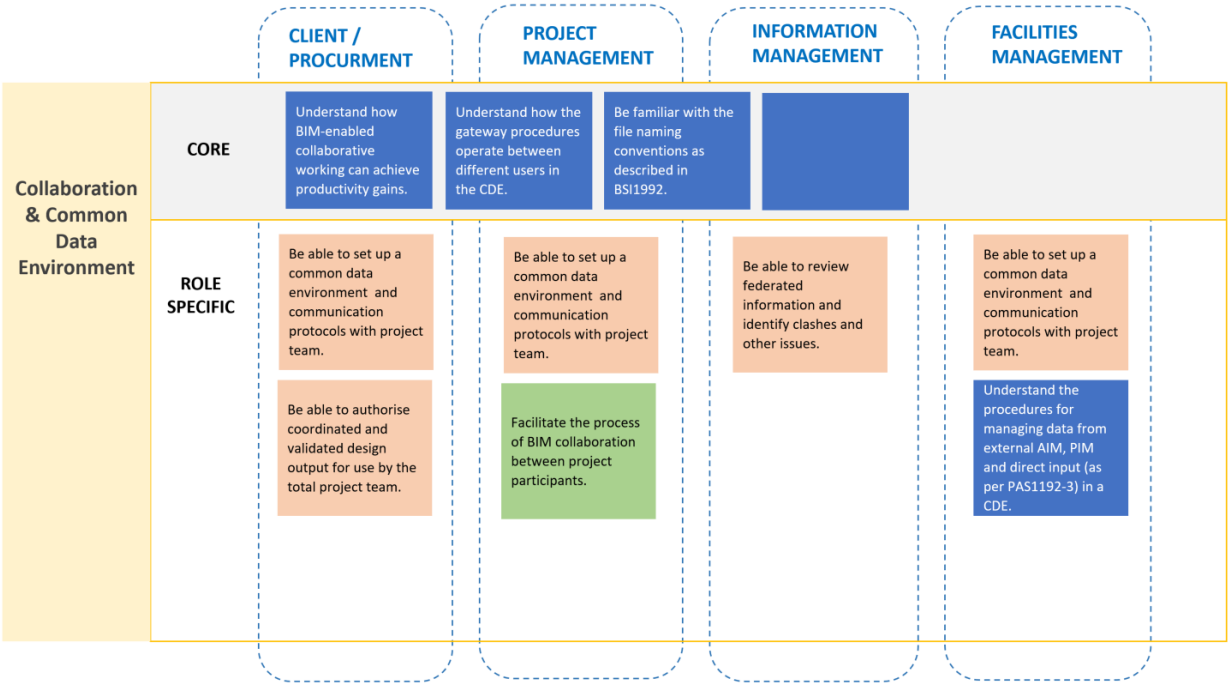


An example of the framework's structure, complete with potential roles and topics has been provided in Appendix 4 for illustrative purposes.

Framework example

The diagram below takes a section of the framework and populates it with competencies for illustrative purposes. In the diagram the colours represent the competency type:

- Blue = Knowledge competency
- Orange = Skill competency
- Green = Behaviour competency



Competency example

Each competency will include a standard set of tagged information. The diagram below provides an illustration of the information tagged to each competency.

COMPETENCY:	**Understand how BIM-enabled collaborative working can achieve productivity gains.**
ROLE:	Core
TOPIC:	Collaboration & Common Data Environment
TYPE:	Knowledge competency
STAGE:	01 Brief
STANDARD:	BS 1192:2007+A2:2016 PAS 1192-2:2013 Section 9: Information Delivery – Production PAS 1192-3:2014 Section 5L CDE and AIM
SUPPLEMENTARY INFORMATION:	BIM Return on Investment tool available at https://bimportal.scottishfuturestrust.org.uk/page/roi-calculator
COMMON TO:	All (Core competency)

Users of the framework should be given the option to search using any of the tags or filters, with primacy given to role and topic.

6.6 Implementing the Framework

This report sets out a recommended approach to the structure and principles of a BIM Competency Framework based on stakeholder engagement and research. The next, and more substantial, stage of work is the development of the framework itself - in particular defining and agreeing the competencies and populating, with a view to maintaining, the framework. It is anticipated that this work would be completed in phases with core competencies agreed first, followed by role-specific ones which could be developed by different groups of experts in parallel.

Development of the framework will require consideration of a number of issues. These are set out as a series of questions below:

- What is the status of the planned updates to the Learning Outcomes Framework, the BIM Academic Framework, and the National Occupational Standards for BIM, and the development of the BuildingSMART Learning Outcomes Framework?
- How well will the updated frameworks above align with the principles, scope and structure of the framework recommended in this report?
- Should the framework assess and capture further learning from competency frameworks from other sectors and align its approach to strategic.
- Who are the key stakeholders who need to be involved in the population of the framework and which organisation is best placed to lead on its development?
- How can the framework best be managed and maintained so that it is kept up-to-date with the evolving standards, activities and roles within the industry.
- What resources will be required for both the development and ongoing maintenance?
- What approach will result in the highest level of uptake and compliance with the framework?
- How will success me measured in the implementation of a framework?

Through, addressing these questions and applying the findings within this research, the opportunity exists to develop a considered and practical approach to implement a BIM Competency Framework.

The implementation of a framework will require sufficient funding, resources, leadership, and collaboration. In doing so, a coherent, consistent and practical BIM Competency Framework can be implemented that is recognised across the UK and will support all areas of industry and academia to deliver a workforce capable of delivering BIM as business as usual.

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Appendix 1 - Existing Provision of BIM-related Qualifications

			Course No.s		SCQF Level											
			Key Area	2nd Area	1	2	3	4	5	6	7	8	9	10	11	12
	Building Information Modelling	BIM	3	0												
Architectural	Architecture	ARC	10	0												
	Architectural Design/Studies	AD/S	15	7												
	Architectural Technology	AT	7	0												
	Draughting	DG	5	0												
	Interior Architecture/Design	IA/D	9	1												
	Landscape Architecture	LA	1	0												
Surveying	Building Surveying	BS	7	0												
	Quantity Surveying	QS	10	0												
	Rural/Land Surveying	RS	8	0												
	Conservation	CN	23	2												
Engineering	Architectural Engineering	AE	4	0												
	Building Services Engineering	BSE	12	0												
	Civil Engineering	CE	49	1												
	Electrical Engineering	EE	34	9												
	Envrionmental/Sustainability Engineering	E/SE	15	7												
	Fire Engineering	FE	2	3												
	Mechanical Engineering	ME	61	9												
	Structural Engineering	SE	16	5												
Management	Construction/Project Management	CM	16	10												
	Environmental Management	EM	12	7												
	Facilities Management	FM	5	0												
	Waste Management	WM	10	0												
	Health and Safety	HS	8	0												
Planning	Law	CL	4	0												
	Real Estate	RE	2	5												
	Transport Planning	TP	3	1												
	Urban Planning/Design	UP/D	20	7												
General Construction & Trades	General Built Environment & Construction	GC	46	0												
	Brickwork	BW	10	2												
	Carpentry and Joinery	CJ	16	0												
	Cladding	CD	4	1												
	Demolition	DM	2	0												
	Fabrication and Welding	FW	7	0												
	Materials	MT	26	5												
	Plant & Eq'ment Installation/Maintenance	PIM	20	2												
	Plant Operation	PO	14	0												
	Painting and Decorating	PD	15	1												
	Plastering	PL	10	1												
	Plumbing	PB	1	0												
	Road Building/Maintenance	RB	1	0												
	Roofing	RF	5	3												
	Site Supervision	SS	10	1												
	Tiling and Flooring	TF	10	1												
	Waterworks and Drainage	WW	7	0												
	Other	*Other*	4	0												

Appendix 2 – List of qualifications (excerpts from database only)

Level	Programme Title	Pri	Sec	Qualification	Owner
11	Advanced Architectural Design	AD/S		MArch	Strathclyde (Uni. of)
11	Advanced Architectural Design	AD/S		PGDip	Strathclyde (Uni. of)
11	Advanced Architectural Studies	AD/S		MSc	Robert Gordon Uni.
11	Advanced Architectural Studies	AD/S		MSc	Strathclyde (Uni. of)
11	Advanced Architectural Studies	AD/S		PGDip	Strathclyde (Uni. of)
11	Advanced Sustainable Design	AD/S	EM	MSc	Dundee (Uni. of)
11	Architectural and Urban Design	AD/S	UP/D	MSc	Edinburgh (Uni. of)
11	Architectural Studies	AD/S		MArch	Glasgow School of Art
11	Architectural Studies	AD/S		MSc	Robert Gordon Uni.
10	Architectural Studies	AD/S		BSc (Hons)	Strathclyde (Uni. of)
10	Building Surveying	BS		BSc (Hons)	Glasgow Caledonian Uni.
9	Building Surveying	BS		BSc	Edinburgh Napier Uni.
8	Building Surveying	BS		HND	SQA Awarding Body
7	Building Surveying	BS		HNC	SQA Awarding Body
10	Surveying	BS		BSc (Hons)	Robert Gordon Uni.
10	Surveying	BS		Grad Dip	Robert Gordon Uni.
7	Air Conditioning Systems Engineering	BSE		HNC	B-DACS
11	Applied Instrumentation and Control	BSE		MSc	Glasgow Caledonian Uni.
11	Applied Instrumentation and Control	BSE		PGDip	Glasgow Caledonian Uni.
11	Building Services Engineering	BSE		MSc	Glasgow Caledonian Uni.
11	Building Services Engineering	BSE		PGDip	Glasgow Caledonian Uni.
10	Building Services Engineering	BSE		BEng (Hons)	Glasgow Caledonian Uni.
6	Site Carpentry	SC		C&G Dip	City and Guilds
11	Structural and Fire Safety Engineering	SE	FE	MEng (Hons)	Edinburgh (Uni. of)
11	Structural and Fire Safety Engineering	SE	FE	MSc	Edinburgh (Uni. of)
10	Structural and Fire Safety Engineering	SE	FE	BEng (Hons)	Edinburgh (Uni. of)
11	Structural and Foundation Engineering	SE		MSc	Heriot-Watt Uni.
11	Structural and Foundation Engineering	SE		PGDip	Heriot-Watt Uni.
11	Structural Engineering	SE		BEng (Hons)	Heriot-Watt Uni.
11	Structural Engineering	SE		MEng	Heriot-Watt Uni.
11	Structural Engineering	SE		MSc	Dundee (Uni. of)
11	Structural Engineering and Mechanics	SE	ME	MSc	Edinburgh (Uni. of)
11	Structural Engineering and Mechanics	SE	ME	MSc	Glasgow (Uni. of)
5	Construction: Floorcovering	TF		NPA	SQA Awarding Body
6	Floorcovering	TF		PDA	SQA Awarding Body
6	Floorcovering (Construction)	TF		SVQ	SQA
5	Floorcovering (Construction)	TF		SVQ	SQA
6	Wall and Floor Tiling	TF		PDA	SQA Awarding Body
5	Wall and Floor Tiling	TF		C&G Dip	City and Guilds
5	Wall and Floor Tiling	TF		C&G Ex. Dip	City and Guilds
4	Wall and Floor Tiling	TF		C&G Dip	City and Guilds
6	Wall and Floor Tiling (Construction)	TF		SVQ	SQA
5	Wall and Floor Tiling (Construction)	TF		SVQ	SQA
7	Logistics Operations	TP		SVQ	SQA
5	Temporary Traffic Management	TP		SVQ	Qualifications for Industry

Appendix 3 - Standards and Documentation

BIM adoption across the UK and in Scotland is being facilitated by the development of a comprehensive suite of standards and supporting documentation. The suite comprises documents that can be split into three categories:

1. **The core suite of BIM standards**
   The table below provides the list of standards which comprise the core suite for Level 2 adoption. Government and industry sponsorship has enabled the core suite of documents to be made freely available online to encourage uptake and best practice. The standards carry the status of either British Standard (BS) or Publicly Available Specification (PAS).

Core Suite of BIM Standards (Available from: *http://bim-level2.org/en/standards/*)	
BS 1192: 2007 + A2:2016	*Collaborative production of architectural, engineering and construction information. Code of practice*
PAS 1192-2: 2013[1]	*Specification for information management for the capital/delivery phase of construction projects using building information modelling*
PAS 1192-3: 2014[1]	*Specification for information management for the operational phase of assets using building information modelling (BIM)*
BS 1192-4: 2014	*Collaborative production of information. Fulfilling employer's information exchange requirements using COBie. Code of practice*
PAS 1192-5: 2015	*Specification for security-minded building information modelling, digital built environments and smart asset management*
PAS 1192-6: 2018	*Specification for collaborative sharing and use of structured Health and Safety information using BIM*
BS 8536-1: 2015	*Briefing for design and construction. Code of practice for facilities management (Buildings infrastructure)*
BS 8536-2:2016	*Briefing for design and construction. Code of practice for asset management (Linear and geographical infrastructure)*

[1] *PAS 1192 Parts 2 and 3 are currently being revised.*

2. **Supplementary standards for BIM adoption**
   The table below comprises a list of supporting BS standards. Unlike the core suite, these documents require purchasing and are only available directly from BSI. It is also important to note that the standards provided here are only indicative. There are a wide range of cross-referenced standards which do not have explicit BIM content but are nonetheless relevant to the new digital ways of working. Relationships with other standards can be found within the foreword of the core standards. The standards provided here are those recommended under the BIM section of the BSI Shop.

Supplementary standards for BIM adoption (Available from: *https://shop.bsigroup.com/Browse-by-Sector/Building--Construction/BIM-/*)	
BS 7000-4: 2013	*Design management systems. Guide to managing design in construction*
BS 8541-5: 2015	*Library objects for architecture, engineering and construction. Assemblies. Code of practice*
BS 8541-6: 2015	*Library objects for architecture, engineering and construction. Product and facility declarations. Code of practice*

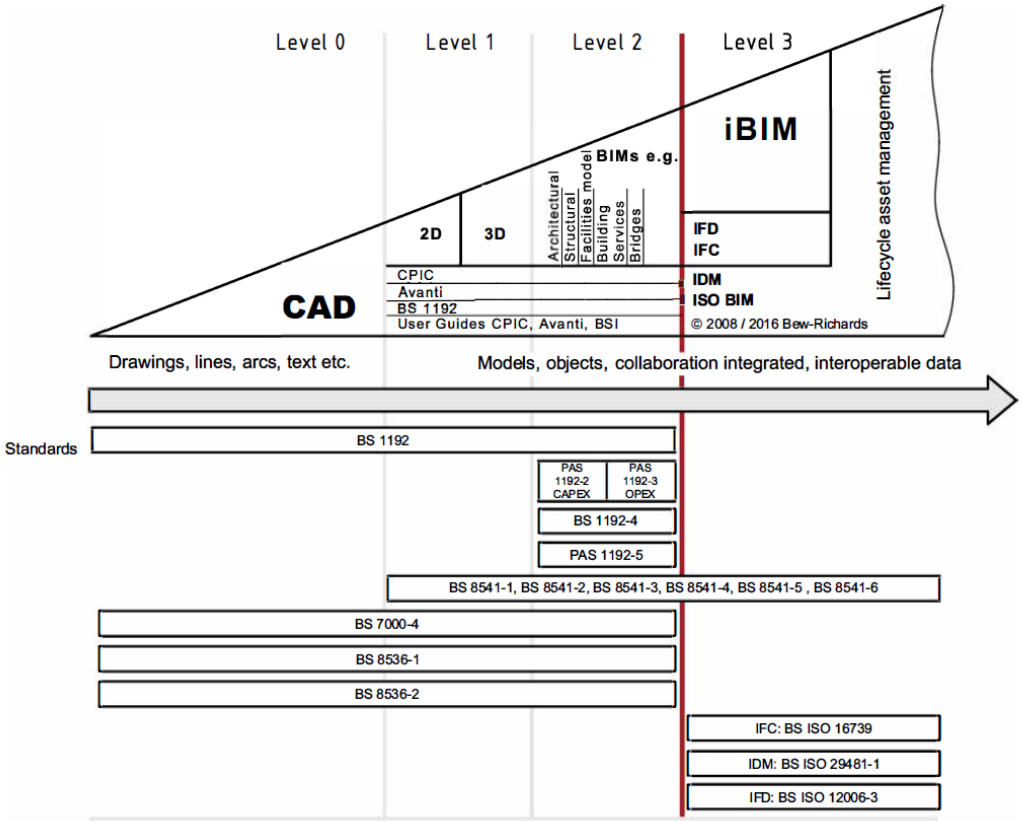
BS 8541-3: 2012	*Library objects for architecture, engineering and construction. Shape and measurement. Code of practice*
BS 8541-4: 2012	*Library objects for architecture, engineering and construction. Attributes for specification and assessment. Code of practice*
BS 8541-1: 2012	*Library objects for architecture, engineering and construction. Identification and classification. Code of practice*
BS 8541-2: 2011	*Library objects for architecture, engineering and construction. Recommended 2D symbols of building elements for use in building information modelling*

3. **Other documentation/tools**
   The table below provides a list of documents or tools which have been developed to support Level 2 adoption, as identified on the BIM Level 2 portal. Although not included on the website, the CIC BIM Protocol has also been included.

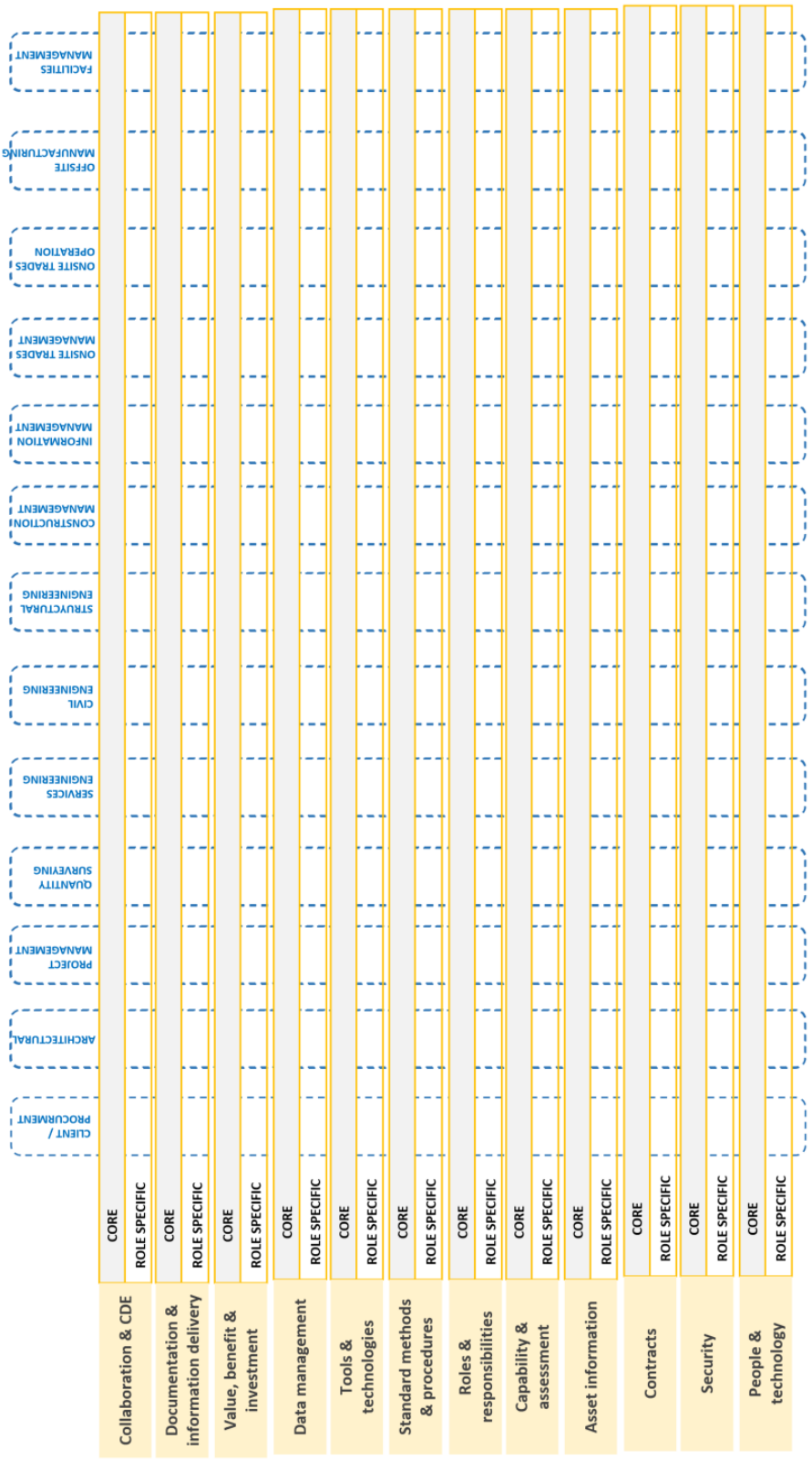
Other documents/tools **(Available from: *http://bim-level2.org/en/tools/* or *https://www.bre.co.uk/page.jsp?id=3508)***	
CIC BIM Protocol	"The Protocol identifies building information models that are required to be produced by the project team and puts in place specific obligations, liabilities and associated limitations on the use of those models." *(https://www.thenbs.com/knowledge/what-is-the-cic-bim-protocol)*
Uniclass Classification	*"Uniclass 2015 is a unified classification for the UK industry covering all construction sectors. It contains consistent tables classifying items of all scale from a facility such as a railway down through to products such as a CCTV camera in a railway station."*
Digital Plan of Work	"A digital plan of work enables an employer to define the deliverables required at each stage of a construction project – from developing the strategy through to managing the asset."

Whilst most standards and documentation have been developed primarily with Level 2 in mind, the applicability of each document to previous levels, and in some instances the future development of Level 3, is illustrated in the Bew-Richards maturity model in the diagram below. The UK and Scottish Governments have based their BIM strategies upon the maturity model, initially conceived by Mark Bew and Mervyn Richards. The Bew-Richards Maturity Model has since become synonymous with BIM adoption, as it has become a cornerstone in the roadmap towards fully integrated BIM. Also known as the BIM Wedge, the model has undergone many

iterations and will likely continue evolving as Level 2 becomes business-as-usual and we start breaching into Level 3 territory.



Appendix 4 – Framework with roles and topics (for illustrative purposes only)



[ii] http://bim-level2.org/en/faqs/
[iii] http://bim-level2.org/en/faqs/
[iv] http://bim-level2.org/en/faqs/
[v] http://www.bicp.ie/
[vi] https://www.designcouncil.org.uk/news-opinion/seven-tenets-human-centred-design , http://www.usabilitynet.org/management/b_design.htm , https://www.usability.gov/what-and-why/user-centered-design.html
[vii] [vii] As BIM is adopted, there is a chance the traditional model built around roles may be challenged. Anecdotally, practitioners are seeing a more responsibility-based model emerging, but it is likely that if this becomes mainstream, there will be a lag between seeing it reflected it the education structure.
[viii] http://bim-level2.org/globalassets/pdfs/learning-outcomes-framework.pdf
[ix]
[x] https://www.gov.uk/guidance/a-brief-guide-to-competencies