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A Critical Review of the Requirements of Quantity Surveyors for Collaborative BIM Engagement and
Success

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Abstract—This paper sets out to critically review the requirements of Quantity Surveyors (QSs) for collaborative BIM engagement and success. The paper has been set in the context of the Irish QS and his reluctance to actively and collaboratively engage in the 5D QS BIM process (5D –the fifth Dimension designated to QSs). A literature review was undertaken to establish the reasons for this lack of QS engagement. The data from these reviews was collected and analyzed and distilled into the main challenges that required resolution to engage QS participation in the 5 D BIM process.

A mixed research methodology based on the principles of Fourth Generation Evaluation was employed as this allowed for both Quantative and Qualitative Analysis. The Focus group members was carefully chosen for “haven been through the mill” haven experienced first-hand knowledge of the barriers faced by QSs as well as for their pro-active interest in engaging and advocating 5D BIM to the highest standards. Different stakeholders were chosen to get different perspectives and views on the problems which were mainly identified as people, process and technology as well as proposals on how the problems might be rectified and by whom.

The results were encouraging, none of the issues were considered insurmountable given time and resources and BIM maturity. The findings were summarized as a lack of a Government Mandate, lack of awareness and upskilling, cultural and collaboration issues. Lack of understanding of the different disciplines, QSs lack of ICT skills and lack of fully functioning and integrated 5D QS BIM software. The BIM world for the QS’s is changing rapidly through the impact of emerging technologies and the Fourth Industrial Revolution. This will be accelerated by the imminent Irish Government Mandate Announcement of Office of Public Procurement (OGP) Mandate on Band 5 Projects from Q2 2019 followed by OGP Band 3 in Projects Q2 2020. The implementation of NBC” Roadmap to Digital Transition For Ireland’s Construction Industry 2018-2021” will seek to collaboratively resolve many of the issues and challenges facing the Irish QS.

However, a key challenge still remains specifically around 5D QS MVD (Model View Definition). There is no universal QS MVD as this would require the adoption of an industry standard approach to costing and different countries, disciplines and segments have their own unique approach to costing. The Irish QS needs to collaborate with other designers and software vendors to develop a QS MVD to harvest the full benefits of what BIM Can offer.

The future is full of new opportunities for the QS’s who become 5D BIM enabled, they can deliver new services such as carbon & energy costing , cost data analytics, extend QS reach into new areas spanning complete asset lifecycle.

Keywords – QS’s, BIM, MVD, ARM4, QS Barriers to Uptake, BIM Mandate

I Introduction

This research paper sets to critically evaluate how Quantity Surveyors (Qs) can have their 5D BIM cost requirements met by the designers of Building Information Models? It also sets out to establish what is required for the QS's to actively and collaboratively engage in the BIM process and resolve these issues for themselves in conjunction with the other design team members and if required software vendors. The literature review is used for data collection and analysis.

Even now many Quantity Surveyors (Qs) execute their core functions RICS (2008) in the same traditional conservative non-digital manner that was first agreed on 15th June 1868 when the Royal Institute of Chartered Surveyors (RICS) held its first council meeting. For many QSs and QS practices, technological advancement has been limited to onscreen 2D/3D Quantity Take off (QTO). There was, until recently, a traditional mind-set engrained in both the QS discipline education and in the practice of Quantity Surveying. This has resulted in an incapacity or unwillingness by the QS to adopt the advantages of BIM and it has been noted anecdotally even by the QS Profession – QS 2020 in Ireland – A time for Digital Transformation, CitA Event, only 21% of the Attendees were QSs .

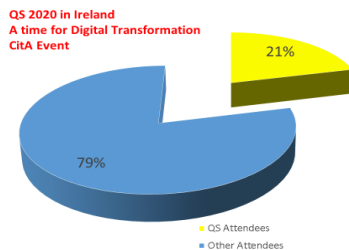


Fig1: Breakdown of QS Attendance at a key QS CitA event
(Source: Author)

”BIM has been described as a game-changing Information Communication Technology and cultural process for the construction sector” Hardi and Pittard (2015). However, research has found that this change has generally not happened for the QS Cunningham (2014). Hence, this research will examine how QSs can become more actively engaged in BIM.

Ashworth et al (2013) state that the traditional role of the QS is to provide the basic project services of cost management of a construction project with regard

to forecasting, analyzing, planning controlling and accounting; these services are still provided by many small to medium size (SME) QS practices today. Hore et al (2009) concur that the traditional services are at the heart of current Irish QS practices.

The QS has generally not engaged in the BIM Process and this research sets out to examine the reasons for and possible solutions to this issue. The software vendor Industry has concentrated largely on the Designers as the vast majority of the design team are designers (architects, structural engineers, mechanical engineers, electrical, HVAC engineers and so on) whereas the QS is a cost specialist whose interest is in effective costing of the construction project process.

Section 11 contains a review of literature on the topic of the lack of the QS engagement in BIM and establishes the reasons why. Section 111 follows with a statement of the methodology used in this research which was a mixed methodology based on the principles of Fourth Generation Evaluation. Section IV deals with the Quantitative Analysis. While Section V looks at the Qualitative Analysis under four different themes. Section VI covers further study on the development of a Pilot QS MVD and Section VIII covers findings for consideration in future developments.

II LITERATURE REVIEW

Literature review was initially undertaken on the published research from the leading Surveying Professional Institutions (UK & Ireland), the Society of Chartered Surveyors Ireland (SCSI) and the Royal Institution of Chartered Surveyors (RICS). This research was broadened to Academia and the Construction Sector. The findings from each source were broadly similar and it was apparent that this was an area of limited research. In particular, there were major concerns that the QS was not deriving adequate benefits from the typical BIM models that are currently produced by design teams Olsen and Taylor (2017).

The research RICS (2014), Zima (2017) Stanley and Thurnell (2014), Kehily (2016) Hardi and Pittard (2015) identified many contributing factors to this problem, such as

- designers not fully understanding the role of the QS in relation to 5D BIM,
- not knowing the level of detail and information required at specific stages,
- their belief in the myth regarding full automatic quantification and lack of understanding of costing software,
- Object detail versus cost detail.

Smith (2014) stated that “The biggest barriers for QS firms adopting BIM were cited as the lack of client demand, training, application interfaces and software.” Lindstrom (2103) concurs that there is a BIM gap in QS training with a lack of QS application interfaces and fully developed and integrated QS costing software.

RICS (2014) in their Information Paper “Overview of a 5D BIM project” have noted a number of issues (which posed their own risks and needed to be overcome) concerning the QS within a working BIM environment. Many QS barriers to collaboration in BIM have been identified and these are broken down into three areas namely, people, processes and technology.

QSs generally were not software/digitally literate compared to designers as prior to the introduction of 5D BIM, it was not an essential requirement. Smith (2014) Concludes that the greatest value to a modern day QS “lies in their ability to be 5D literate and to be able to utilise electronic models to provide detailed 5D estimates and living cost plans in real time “

QSs have now to the realisation that not only do they need to be proficient in 5D software but they will also need to be able to understand and utilise designer software if they are to sort out software compatibility/ interoperability issues, as well as allow them to be able to interrogate the models, to push and pull data as and when required and function fully in a 5D BIM collaborative environment.

Holzer (2016) in his paper “BIM’s Seven Deadly Sins” exposed seven prevailing practices that affect the uptake of BIM for Designers which are also listed in my research as being problems for QSs namely 1. Technocentricity, 2. Ambiguity, 3. Elision, 4. Hypocrisy- the IPD excuse (integrated Project Delivery), 5. Delusion- asking for 2D while requiring 3D, 6. Diffidence - denying the need for process change and 7. Monodisciplinarity - design exploration in professional silos, these are further addressed in Sections IV and V.

According to Zima (2107) the quantity and quality of information entered into the model and collected in the model during the design phase has a big impact on Bills of Quantities (BoQs). Furthermore, the information within the model affects the success of the construction project and consequently significantly influence the costs of the construction works.

Olsen and Taylor (2017) also captured this sentiment stating that “Some companies have been hesitant to invest in BIM simply because the traditional method has worked for so long; and it is always risky to invest time and money into a new method that has not been tested and proven”.

There was also a fear and mistrust among QSs of what automatic quantification might mean due to the knowledge that automation in its current

state was approximately 61-80% (at best) BIM enabled (Olsen & Taylor 2017) and ,therefore, clunky and flawed.

Furthermore, neither discipline - design or QS fully understood or were prepared to rectify existing software deficiencies within their respective software to allow for fuller interoperability as this was outside of both their comfort zones, particularly as they did not fully understand each other’s requirements. Put simply, QSs are not designers. While designers think in pictures, QSs think in numbers. This accounts for some of the difficulties in relation to communication and collaboration between the Disciplines.

There is a great lack of 5D case studies (RICS 2014) from which to learn from others, to evaluate the findings, to stress test and learn lessons. Coupled with this, the UK Government in its level 2 BIM mandate (UK mandate 2016) only stated that this level of BIM *may* utilise 4D construction sequencing and /or 5D cost information. In sharp contrast to this the forthcoming level 3 BIM mandate states that 4D, 5D and 6D project lifecycle management information must be used (Digital Built Britain (2015).

Plebankiewicz, et al (2015) have found from their research & analysis on several leading market BIM-based cost estimation software programs; that none of them suits the Polish market. The authors set about devising their own costing system, specifically for the Polish Situation called the BIMestiMate and the BIM vision browser. The authors identified a number of flaws in their software including a lack of automatic simplified cost estimation and the inability to organize and save quantities by different classifications, such as Omni class or Unifomat. The authors hoped that their system would be evaluated as appropriate and applied in the Polish BIM-based cost estimation. The opportunities and solutions offered by the Polish application seem to have made a significant contribution to software development for QSs. However, this software has three major drawbacks namely quantities can’t be organised and saved by different classifications such as Omniclass and lack of automatic simplified cost estimation and data can’t be saved from cost estimate to the BIM model different which makes it unsuitable for universal adoption by QSs.

The current research identifies the problems but does not give the solutions. XU, et al (2014) outlined similar QS issues with BIM but did not chart a clear way forward or a workable solution to the problems. They showed that great strides been made in trying to make 5D BIM fit for purpose. However, they acknowledged that there are still inherently many software and interoperability issues for the 5D BIM QS.

Abanda, et al (2017) in their research on measurement ontology stated that, for generations,

the process of cost estimation has been manual, time-consuming and error prone. Emerging BIM modeling can exploit standard measurement methods (SMM) to automate cost estimation process and improve inaccuracies. Structuring SMM in an ontologically & machine readable format for BIM software can greatly facilitate the process of improving inaccuracies. Abanda et al (2017) used methontology (*is a well-structured, methodology to build ontologies from scratch*) to develop an appropriate ontology (Fernandez 1997).

The authors discussed the process that was undertaken, presented its limitations and successfully tested the core ontology on Navisworks. The authors stated that as part of a future study, this ontology would be tested on other BIM software systems such as Autodesk QTO. They expect that other end users can adapt or transform the complete ontology in this study to meet their various needs. For example, to use for the Irish Method of Measurement- ARM4.

Smith (2014) explored the necessity for project cost management professionals to be integrally involved across all construction project phases and to embrace the 5th dimension. These adaptations would enable QSs to become key players in the BIM environment. He concluded that the greatest value to the modern day QS lies in their ability to be 5D literate and to be able to utilise electronic models, provide detailed 5D estimates, and living cost plans in (almost) real time.

The Irish Government has not as yet mandated Level 2 BIM (although it is imminent - OGP mandate for Band 5 Projects in Q2 -2019, followed by OGP mandate for Band 3 Projects for Q2 2020). Therefore, BIM is not presently a requirement for Public Procurement Works.

The proposed research through its objectives proposes to fill some of the gaps that were identified. The main findings from the Literature review has been to establish what are the barriers that are preventing QS's from actively and collaboratively engaging in the BIM process. These have been summarized as:

1. People - who operate in a cultural discipline silo mind-set where BIM is not currently mandatory.
2. Process – there is a lack of awareness, interest and QS expert knowledge in the BIM/5D BIM process.
3. Technology – there is a lack of suitably developed integrated 5D QS BIM software availability. Put simply there is no universal QS MVD (Model View Definition).

The literature review has been mainly on non-Irish Publications owing to the limited availability of Irish data. This is due also to the RICS being an UK and International Professional Body, with the SCSI being a smaller Irish Professional Body. Other methods of research have been used to check if the Irish Situation is the same. The proposed solutions are reviewed under Sections IV and V.

III Methodology

A mixed research methodology based on the principles of Fourth Generation Evaluation (FGE) was employed. This allowed both Quantative and Qualitative Analysis (Guba and Lincoln 1989) to be used.

The Stakeholder interview members were carefully chosen because of their experience in the sector and for their interest in engaging with and advocating BIM to the highest standards. They had first-hand knowledge, of the barriers faced by QSs, and had examined many issues, claims and concerns but took the view that QSs must “stop sitting on the fence” and should instead engage proactively with other professionals to find solutions to the problems which when examined, were actually design collaboration, QS, process and technology problems.

These individuals were and are actively involved in different capacities in various BIM working groups (both nationally and internationally) and are at the forefront in advocating for the use of BIM. These QSs recognise that they are best placed to fix their own QS problems themselves. They recognised the need to adapt, upskill and collaborate and thus they have transitioned from the non-BIM to BIM-based environments.

See Fig 2. For the steps used in the mixed research methodology.

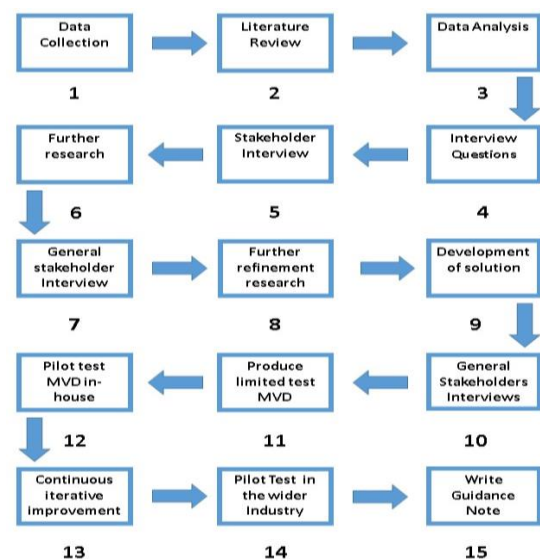


Figure 2: Steps used in Mixed research Methodology (Source: Author)

Please note that steps 13, 14 and 15 are currently outside the scope of this research.

The literature review was used to research, analyze and distil the issues that QSs have in BIM Adoption. This analysis was then used to produce interview questions which in turn was used to elicit responses from the Stakeholder Group to the research question.

Different stakeholders were chosen to get different perspectives and views on the problems as well as proposals on how the problems might be rectified. Some of the main stakeholders were interviewed numerous times, either by face to face interviews or telephone conversations to further develop and tease out the issues and the proposed solutions. Please note that a number of different interview methods were used throughout this process. Some interviews were recorded, some interviews were by phone only, and some interviews were in person, taking notes.

The Main Stakeholder Group were interviewed numerous times using a combination of different interview techniques. The Focus Group comprised of 10 participants, 5 of which were QSs, three of the QSs were from the Private Sector, one from the Public Sector and one from Academia. Two of the other participants were Structural Engineers, One Private sector & one Public sector, two of the participants were software developers & vendors. The last participant was a Public sector BIM architectural Technologist. The General Stakeholder Group had three additional QSs for broader analysis of the issues and clearer refinement of the solutions as well as two other design professionals.

IV Quantative Analysis

The Desk study revealed a myriad of reasons for the lack of QS engagement in the BIM process. This quantative data was then collected and analyzed under three main sections headings as Figure 3

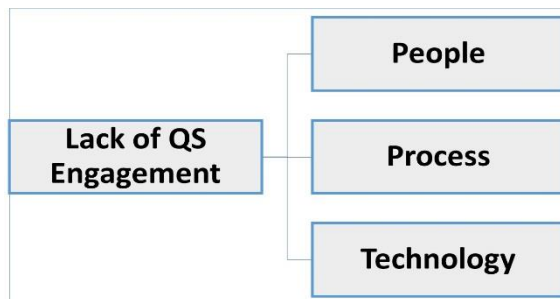


Figure 3: The three main reasons for lack of QS Engagement in BIM (Source: Author)

Under each of these 3 headings the problems encountered was listed and the author proposed solutions for discussion with and evaluation by the interviewees. See figure 4. The feedback received from the Main Stakeholder Group informed the Interview questions.

1 People Problems	
Problems encountered	Proposed Solutions
Traditional working still does the job, is within comfort zone and is low risk.	Raise awareness of the benefits of 5D QS BIM.
Silo discipline education.	Interdisciplinary modules in Undergraduate QS Degree Courses.
QS's are not designers, basically number crunchers	Need to understand how designers operate and collaborate with them.
Not mandated by the Irish Government.	Mandate BIM to drive change.
Need for cultural change- Mind-set 90% of issue.	Awareness campaigns by Professional Bodies. Seminars/ Workshops
No buy-in from management.	Show Return on Investment.
Myths about what BIM is – Still perceived as 3D CAD and clash detection.	Awareness campaigns, seminar/workshops by Professional Bodies.
Brexit seen as more imminent risk.	Government needs to include BIM within its priorities.
5D BIM not mandated within the UK level 2 (2016) mandate therefore QS's assumed not particularly relevant to them, thus slow uptake.	Raise awareness of the benefits accrued to 5D BIM uptake.
No exemplar 5D BIM Case Studies to learn from.	Exemplar 5D BIM studies required best provided by Academic Institutions.
5D BIM in its present state not a perfect solution – Too many inherent issues, so why bother?	Inherent issues are resolvable with collaboration from the Design Team.
5D Exemplar Case Studies difficulty to accrue owing to Client insistence on confidentiality, particularly in the Private Sector.	Adopt American system of using percentages Instead of numbers. Academic Institutions & Public Sector provide where possible
Not incentivized to engage or collaborate within the 5D BIM Environment.	Clients need to actively engage consultants for their professionalism in the 5D BIM Area. The Government needs to take the lead and mandate for Public Sector Projects.
Not paid for 5D BIM services.	Fees need to be restructured to include any additional 5D BIM services.
Lack of suitable integrated courses for the training of 5D BIM QSs or (short courses) for upskilling of existing working QSs.	Academic institutions need to restructure courses including continuous modules on ICT skills and on interdisciplinary collaboration.

1 People Problems	
Problems encountered	Proposed Solutions
Peoples anxieties – Fear of the unknown Being made redundant. New roles – new projects team configuration. New responsibilities. Changing work practices.	Leadership/management need to acknowledge and cater for these anxieties by providing training and re-sources together with meetings, informal evenings etc. explaining the new changes and allowing for question and answer sessions.
BIM Acronyms – With widespread use of this terminology it causes confusion & is off-putting.	Glossaries provides at all times with plain language explanations.
Difficulty in recruiting BIM -enabled staff and cost of training existing staff.	Invest in upskilling current staff – invest in delivering via Academic Institution BIM specific modules tailored to needs of the business.
Please note that the list of people problems is not exhaustive but are a result of this research.	

2. Process Problems	
Problems encountered	Proposed Solutions
Lack of QS expert knowledge in the BIM/5D BIM Process.	Awareness campaigns by the Professional Bodies- education gap for the Academic Institutions.
Industry not ready for “full blown BIM” e.g. planning process not transitioned to digital planning process.	Implement E-planning to accept BIM models while concurrency also accepting traditional planning applications.
Intellectual property (IP) and copyrights.	OGP (office of public procurement) are researching this with recommendations for Best Practice & eventual implementation.
Discipline roles not fully agreed and defined – Who is responsible for what role.	Roles need to be defined without ambiguity within the Construction Sector. The new roles need to be created Officially within the Public Sector – The Government BIM Mandate will accelerate this process.
IPD (integrated project delivery) BIM Maturity in Ireland is not there yet.	This requires substantial buy in from many stakeholders but most particularly from the Government and private sector clients.
Lack of specific definitions of distinct QS 5D BIM related activities/distinct BIM services as they are emerging in practice.	Need defining by the professional bodies showing added value of specific services – with associated spectrum of fees.
PI (professional indemnity insurance) and insurances generally relating to the construction industry have not fully integrated BIM within their provisions. There is lack of uncertainty regarding responsibilities, risk and legal status.	The professional Bodies, the Insurance Industry, the Construction Industry and the Government need to engage and collaborate on the resolution of these issues.

Sharing of risk fairly amongst Clients, Professionals , Contractors etc.,	The professional bodies, the Insurance Industry, the Construction Industry and the Government need to engage and collaborate on these issues. Look at the use of Integrated Project Insurance Models as one possible solution
Most SME Contractors not yet fully adapted for full BIM integration.	Overhaul of contracts required for early contractor involvement and integrated team BIM inclusiveness. Review and revision required by the GCCC Contract Committee
The integration of early contractor involvement – is a major mind-set change from the long established traditional method of design for designers, clients and even contractors.	Changes requires to contracts and procurement to allow for this. Suspicion over early contractor involvement will eventually be resolved by emerging standards and rules.
Lack of both budgets and expertise in setting up 5D BIM libraries and templates and for the training of staff in the use there in.	The professional bodies need to give guidance, develop and procure standard templates as well as involve the supply chain and technology vendors in the process.
Incomplete model audit trails	Rectified by ICT technology
Unclear standards – New ISO standards ready for usage with further new ISO standard evolving to replace the PAS Standards – in transition period.	Currently in a transition period where all the required Standards cannot be fully integrated into the Irish BIM process as yet, owing to uncertainty because of Brexit and continual evolution of standards.
Naming conventions – causing some confusion and reluctance to use correctly – mind-set.	Education and awareness of benefits of proper naming convention as well as utilizing software to where possible automatically name.
Public sector in a vacuum when trying to agree & implement BIM Processes, SMP's etc. universally on large Public Sector BIM Projects as BIM not yet mandated by Irish Government	Ongoing process and discussion within Public BIM, an Alliance of Public Sector Bodies , trying to align Public Sector Processes
Unsuitability of ARM4 (agreed method measurement as not digitized, and not suitable for automatic quantities - Also outdated – Last revised 2009 pre- BIM.	A Working Group has been established to review and update in line with International Best Practice, modern construction methods and BIM integration
Classification used within ARM 4 currently under review as NSBE (An Irish System) no longer fit for QS's working internationally.	A Working Group has been established to review and update in line with International best practice & proposed adoption of ICMS Classification System
Clients not asking for 5D BIM service	Offer to Clients as a value added service
Please note that the list of process problems is not exhaustive but are a result of this research.	

3. Technology Problems	
Problems encountered	Proposed Solution
Perceived cost (rather than investment) of software licences and cost of upgrading computer hardware and network capabilities.	Show significant savings through return on investments. The cost of software & ICT Maintenance should have a budget allocation In the business plan –the cost BIM should be an extra over ICT requirement.
Substantial cost of training staff in ICT.	Show the negative cost of not training and upskilling staff.
Lack of budgets.	Need to make case for investment and show pay back.
Different methods of modelling by different design professionals even within the same practice.	Adoption of standard approach of modelling (SAM). Similar to the Modelling Standard used by Hong Kong Housing authority.
Object detail verses cost detail.	Designers need to be educated regarding QS requirements.
Items not modelled.	Need linked schedules.
Items missing entirely.	Rely on QS Expertise.
Rogue items.	Rely on QS Expertise.
Items incorrectly labelled or modelled.	ICT issues with different software's.
Please note that the list of technology problems is not exhaustive but are a result of this research.	

Figure 4: The reasons for the lack of QS engagement in the 5D BIM process

Six key over-riding themes emerged from the interviews.

1. Qs had very little faith in the data in most current BIM Models as they were incomplete, generally of poor quality and not modelled to a level suitable for the QS automatic quantification. This was seen as the greatest barrier to QS BIM engagement by all Stakeholder.
2. In general, design teams had insufficient understanding of the role of the QS in relation to 5D BIM. This lack of understanding was viewed as the second most significant problem by Stakeholder.
3. No QS MVD is available that allows for automatic Quantification. This was viewed by the Stakeholders and the Stakeholder as the single biggest advantage of BIM to the role of the QS in construction i.e. increased speed and accuracy of QTO (Quantity Take off)
4. There was a shortage of suitably skilled 5D BIM Qs who fully understood the BIM Process as well as having the necessary digital skills for interrogating models, pushing and pulling cost rich information.

5. BIM was not yet mandated by the Irish Government and was therefore not a requirement. This however has been categorised as a short term problem by the author as the Government Mandate is imminent.
6. The BIM protocols, Standards, Contracts etc. were either adopted from the UK or pre BIM without being fully integrated into Irish BIM context. There are issues around IP (intellectual Property), copyrights, insurances, the legal status of the BIM model, and so on. This was further complicated by Brexit. However, this was seen more as a problem and an issue common to all the professionals than just a QS item.

V Qualitative Analysis

In the second phase of this research the secondary Stakeholder group was used to further refine issues articulated by the main Stakeholders and expand the solutions presented with additional information from further research for their consideration. It was during this phase that opportunities for development and education arose and there was general consensus on both the issues and the possible solutions.

This was an iterative process and as the process and was distilled, a number of stakeholders were interviewed numerous times. These personal interviews were advantageous as the participants spoke freely about their experiences, how they overcame issues and what insights they had gained and what could be improved upon on hindsight.

A very important insight from the research was that the Qs need to be realistic and pragmatic in their expectations and realise that BIM is not a perfect digital solution but an imperfect digital advancement with great potential. Qs in the traditional world accepted less than perfect un-coordinated drawings, frequently resulting in well-documented overruns in terms of time and cost. There is always some quantifiable data even in bad models and Qs's need to know how to navigate the model and articulate their requirements by collaborating effectively with Designers to acquire the information in a useful format.

a) BIM Process Challenges

The desk study review revealed issues with the BIM Process:

- Such as contracts and procurement not BIM aligned

- No Irish SMP's in place
- No proper BIM protocols in place
- Transitioning difficulties from the PAS standards to ISO standards
- What standards to use where no ISO standards in place
- Use of Uniformat or Omniclass
- The legal status of the BIM model
- The legal and practical implications of Brexit and so on.

The Stakeholder Groups were less concerned by the BIM process challenges revealed through the desk study. Since the National BIM Council (NBC) had produced a Roadmap to Digital Construction For Ireland's Industry 2018-2021 with timelines, funding and resources in place for resolving these process issues. The Irish Government recognized that these transitioning process issues pose significant barriers to the proper implementation of BIM and delivery of the Government's promise of a 20% reduction in project delivery programme, 20% reduction in capital costs and 20 % increase in construction exports.

These Process problems were also common to other design professionals, contractors and clients and were part of the bigger BIM picture and not exclusive to QSs alone. The Stakeholder Group took the view that the mandating, implementing and practicing together (maturing) the BIM process would eliminate these problems through iterative revisions overtime. However, the main concern of the Stakeholder group was that QSs proactively engage in those working groups so that QS voices are heard (cease distancing ourselves from the BIM process as we have traditionally been doing) and their needs articulated and catered for in the future solutions to BIM problems.

The Stakeholder group also recognised that a number of the process problems could be eliminated by the QSs themselves,

- Becoming properly informed of what BIM is?
- Understanding the production and delivery of information
- Understanding team/data exchange formats and information drops,
- Having their QS requirements comprehensively incorporated into the BEP,
- Recognising when data or drawings are not complying with the BEP (BIM Execution plan).

These process problems can be addressed by the QSs fully engaging and upskilling in the BIM process which, prior to now, was a question of lack

of awareness and education and engagement. The SCSi (2017) survey, Chartered Quantity Surveyors' Perspective on BIM clearly pointed towards an increase in adoption of BIM by the Irish QSs and showed that many firms/individuals had planned for further adoption in the near future. QSs who have not done so before now must start to engage and up-skill as it will cease to be optional in line with the imminent Government BIM Mandate.

b) Skills Shortages

The literature review revealed that QSs have a skills shortage particularly in the 5D QS BIM area. This is widely acknowledged within the QS Profession. A recent comprehensive report by Dr Roisin Murphy (2018) on "Employment Opportunities and Future Skills Requirements for Surveying Professions 2018-2021, predicted shortfall of 1,652 (taking a Median 3% growth) QS Positions spanning from Director to Graduate level to the year 2021.

This news is hardly surprising following a deep and prolonged recession where numerous QS's emigrated and at the same time there was a large fall off in students entering the QS profession.

The predicted shortfall of 1,652 QS professionals is a concern when one considers that currently the total number of QS's (from Graduate to Director/Partner level) within the Irish Construction Sector stands at 4,327. The report states that if the pessimistic predicted growth of 2% should occur, the expected shortfall will be 898 QSs at all levels. On the other hand, should the optimistic prediction occur there will be a shortfall of 2,558 QSs (at all levels), and this will have consequences for the medium to long term implementation of 5D BIM.

The desk study concurs and is consistent with the views expressed by the 5D BIM QSs Stakeholders in this research. The large 5D BIM QS Practices are actively recruiting QS Graduates, who leave college with a promise of an immediate career progression.

These QS Practices are recruiting abroad where suitable QSs can be found. QSs who previously emigrated and now have international experience have difficulty finding suitable affordable accommodation in Ireland due to the current housing crisis.

The author's own work place has taken the decision to invest and upskill their existing QS staff, as these QS staff are viewed as their greatest asset. This is a view that will be adopted by many of the SME QS firms, who have limited options.

c) Collaboration

This is seen as an issue not only for the QSs but also for other design professionals. The UK Government Mandate (2016) did not require the QSs to collaborate with the BIM Models. However prior to the mandate the Farmer Report (2016) the Egan Report (1998) the Latham Report (1994) and others criticized the UK Industry for its poor collaborative culture, fragmentation and lack of stakeholder involvement.

Pinsent Masons (2016) in their report state that collaborative construction is more a myth than a reality and cite five main reasons why collaboration does not work, namely absence of trust, fear of conflict, lack of commitment, avoidance of accountability and inattention to details.

At the “QS 2020 in Ireland”, CitA event, a leading 5D BIM QS stated that in his BIM experience, we have moved from a 2D silo to a 3D Silo and he was referring to the whole team. The Stakeholders take the view that Collaboration will occur over time as, for now, there is a lack of maturity in BIM Level 2. When Level BIM 3 becomes embedded in practice to the point of “business as usual” we will then have achieved a high level of collaboration, iBIM or BIM Level 3, is centered around IDM, IFC (Industry Foundation Classes) and IFD, the qualities that allow for a fully integrated and interoperable BIM process and that reduces risks and actualizes saving through this very collaborative process.

Collaboration will also be achieved through integrated learning in HEI’s amongst the design professionals.

d) Creation of a QS MVD

One of the major findings revealed through the interviews and Fourth Generation Evaluation was essentially a major malfunction between processes and software. This was attributed the lack of a readily available QS Model View Definition (MVD). The designer software has inherently built into their functions a Design MVD for the specific requirements of the designer. Such a function does not exist within capabilities of QS Software typically used in Ireland. Such a QS MVD would enable the automatic quantification of quantities (Thus the commonly held fictional “push button myth” associated with automatic take off would evolve into a virtual reality) linked to an international classification system that was commonly used by all designers linked to an agreed Method of Measurement.

The Stakeholders QSs believe that the greatest benefit to them is the increased speed in

QTO. The next biggest benefit is the increased accuracy of the QTO and a very desirable benefit is 5D BIM and live cost plans. These findings corroborated the desk study outcomes, as well as the SCSI Survey on Chartered Quantity Surveyors perspective on BIM (2017).

In the author’s work place, the use of QS Mudshark software, achieves a 90%-time saving compared to manual take off achieving the same levels of accuracy. According to Construct IT, BIM – Threat or Opportunity, A Quantity Surveyors Perspective, Dubai Mall saved more than 700 man months by automating the QS task, saving \$7 million in improved efficiency of 86%on an overall massive project cost of \$1.3billion & 12million sq. ft.

The solution to the QTO problem is the creation of a QS Model View Definition (MVD). This is a major task. However a simplified version would still create massive time savings until such time as industry evolves to create a fully integrated information exchange. Desk study has shown that various QS MVD’s have been developed and tested in different jurisdictions but all have their limitations and all require further research and development. Abanda (2017) in his paper BIM – New rules Of measurement ontology for construction cost demonstrated the attainment of his research objectives but acknowledges that three major challenges were encountered

Abanda, concluded that he has tested the core ontology on only Navisworks (which is not QS QTO software) and as part of future study, this ontology will be tested on other BIM software systems such as Autodesk QTO. Also it is expected that other end-users can adapt or transform the complete ontology in his study to meet the various needs.

O’Keeffee (2016) completed a similar study using Vico office software and Omniclass. Whilst it was successful he concluded that there were a number of issues one of which that Vico does not support IFC. The tasks were sunset midway through the project when the research team and USACE team decided to abandon the proprietary software and develop an alternative solution for BIM databases

None of the QS/QTO information exchanges MVD’s are suitable for the Irish QS Market There are a number of reasons for this lack of suitability. The Irish QS has his own Method of measurement called ARM4 and they have their own classifications systems, both of which are under revision. The author has looked at the current QS Environment and recognizing the current limitations has devised a simple mapping system See figure 5.

The author has proven that even in its present format it is still possible to map ARM4 and the uniclass 2015 classification system, see figure 6 spreadsheet.

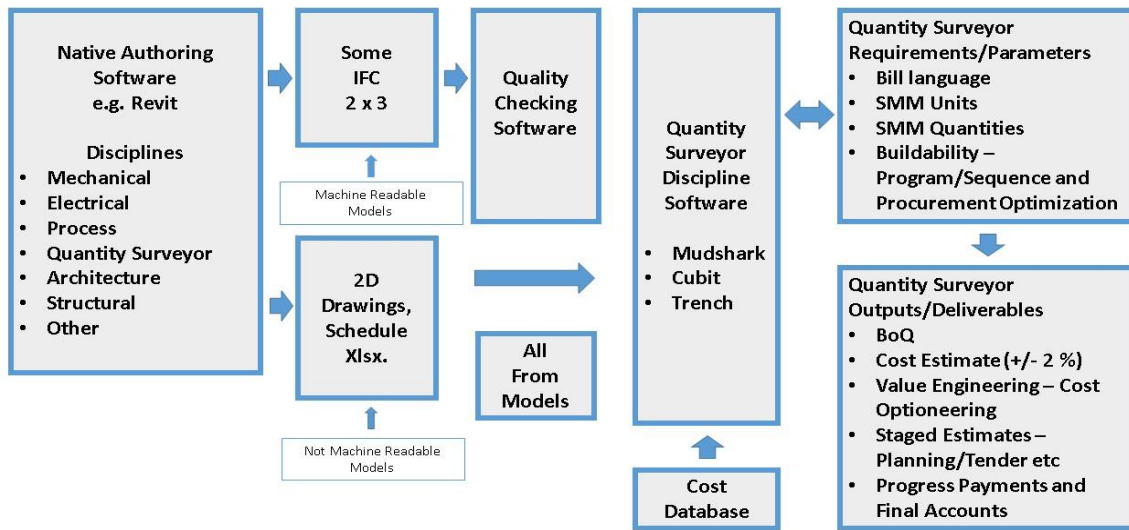


Figure 5: Simplified Mapping from native authoring software to QS authoring software

Bill Ref	Description	Quantity	Unit	Rate	Markup	Total	ARM	UniClass 2015
A/2F	100mm thick	19.00	m2	24.27	0.00	463.03		
A/2G	215mm thick	73.00	m2	51.81	0.00	3782.13		
	Autoclaved aerated concrete thermal common blockwork; to BS EN 771-4 or equivalent EU Standard; 0.18W/mK thermal conductivity; 440mm x 65mm x 215mm; GPLM tolerance category; half lap stretcher bond; all in accordance with the Works Requirments Documents						G-48-3-1-0-0	Pr_20-93-52-05
	Walls							
A/3A	100mm thick; 2 courses	15.00	m	15.37	0.00	230.55		
A/3B	215mm thick; 2 courses	15.00		16.00	0.00	240.00		
	Clay facing brickwork in blended batches to BS EN 771-1 or equivalent EU Standard; colour and texture to....							

Figure 6 Simple mapping of ARM4 to UniClass 2015

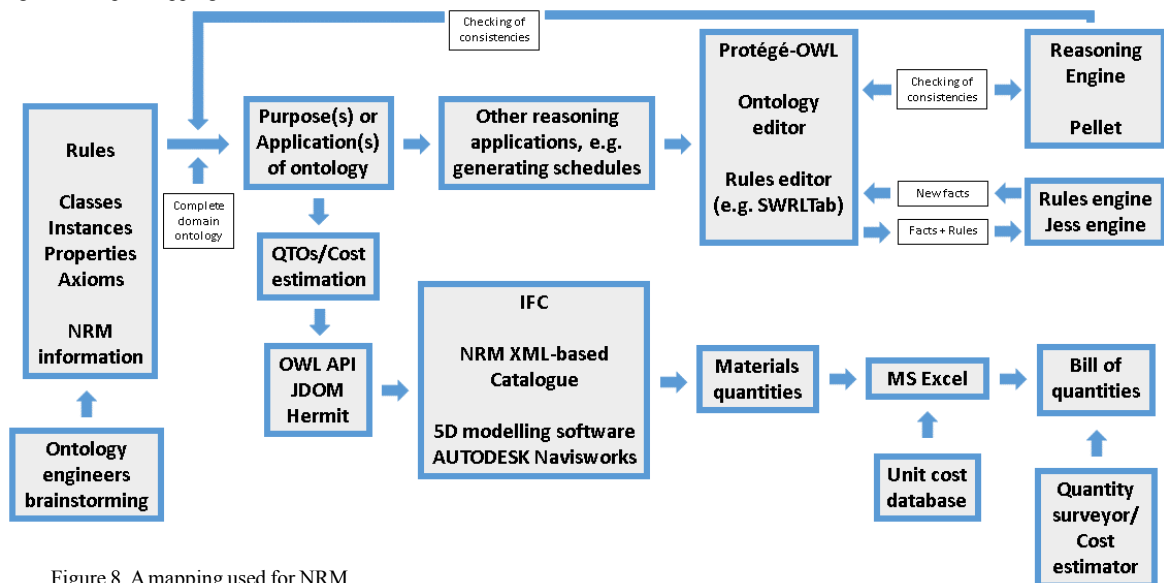


Figure 8. A mapping used for NRM.

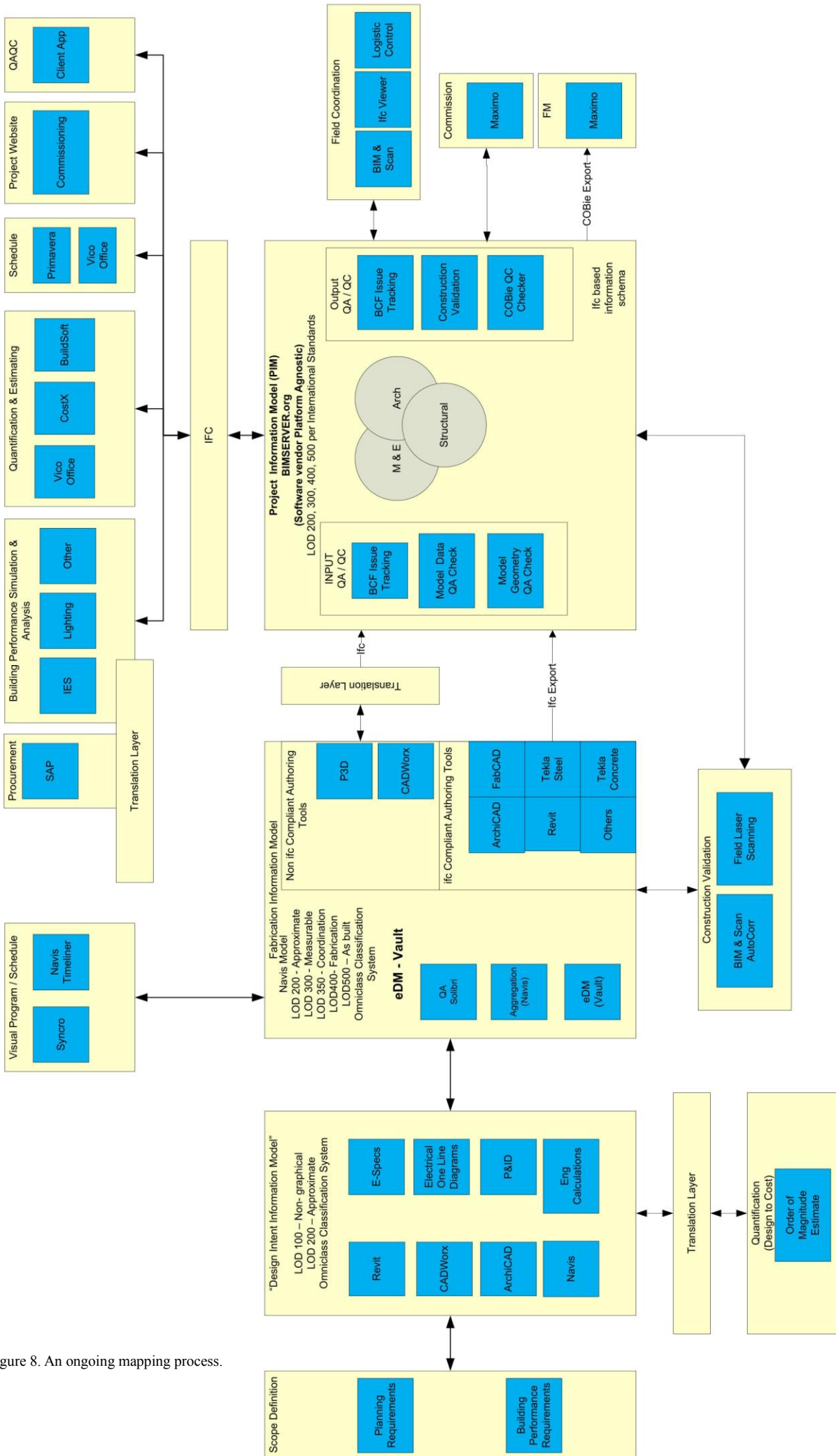


Figure 8. An ongoing mapping process.

V1 FURTHER STUDY

The author has demonstrated that a QS MVD is achievable for practical use within the Authors' work place and that it will be developed for long term use. The author does however recognize that it is an imperfect solution and that it has its limitations in its current state. However, these are greatly outweighed by the long term ROI in time and resources.

The author acknowledges that there is a cost and time frame involved in the development of this QS MVD but due to advantages accrued from similar type repetitive work and the setting up of a 5D BIM Library and Templates as well as the on the job practical training for the 5D BIM Qs it is a worthwhile endeavor.

The author intends to trial this QS MVD on Pilot Schemes in-house initially and later when it has been reviewed and if successful extend the trialing to other Public Bodies using similar software for review and feedback. This process will be viewed as an evolving iterative process and will be updated on a regular basis for example when the new revised digitized ARM 5 (or equal equivalent) comes into force as well as the New ICMS classification (or some version thereof).

V11 CONCLUSION

Due to lack of maturity in 5D BIM there is presently limited experience and knowledge amongst professionals. This contributes significantly to the challenges facing QS's and of implementing 5D BIM.

From the significant list of challenges which were articulated through the mixed methodology research, none of these impediments were deemed insurmountable. Some will involve greater timeframes and resources than others.

The mandating of BIM by the Government in line with NBC Roadmap to Digital Transition – For Ireland's Construction Industry 2018-2021 will assist with resolving many of these impediments through the key actions listed on pages 15 and 16 which cover the core areas of leadership, Standards, Education and Training and Procurement.

However, some the challenges listed will continue to present significant impediments to an uptake of 5D BIM for Qs. These are QS specific challenges such as the creation of a QS MVD for the automation of quantities which are correctly classified under Agreed Rules of Measurement.

McKinsey (2017) in its paper "Reinventing Construction: A Route To Higher Productivity" defined seven areas that could boost sector productivity by 50-60% which could equally apply and could have been written for QS uptake of BIM as these are

the very challenges listed by the QS namely 1. Reshape regulation, 2. Rewire contracts, 3. Rethink design, 4. Improve procurement and supply chain, 5. Improve onsite execution, 6. Infuse technology and innovation, and 7. Reskill workers.

Hardi (2015) "findings from this paper indicate that a shift towards collaborative working within the construction is crucial to ensure that BIM is implemented fully and for its benefits to be wholly realized" Pinsent Masons (2016) in their paper find that actual collaboration in its proper meaning is more a myth than a reality, this has been further corroborated by 5D BIM QS

V11I FINDINGS FOR FUTURE DEVELOPMENTS

A number of recommendations from a QS perspective have emerged from this research.

1. ICT Skills should be incorporated as a standard module, increasing in complexity year on year, for the duration of the QS undergraduate degree in all Academic Institutions. This will bring much needed ICT skills to the QS and remove the traditional silo mind-set.
2. Modules catering for Interdisciplinary collaboration between other Design disciplines resembling real life working experiences should be introduced in the final two years of the QS undergraduate degree in all Academic Institutions so that graduates leave college with a collaborative mind set.
3. QS Professional Bodies and Academic Institutions should encourage interdisciplinary research in conjunction with software developers to develop a QS MVD for use by the Irish QS. This would be most useful QS Tool that can be developed for QS BIM Integration. Research & Development should be undertaken on other collaborative (IFC based) software/APIs that will seamlessly integrate evolving 5D BIM QS requirements into design software for data analytics and predictive analytics, looking at buildability issue.
4. Professional Institutions need to provide more advertising and awareness campaigns on their websites, in their Journals, in their media publications defining in plain language what a 5D BIM

QS is and the value they can add to construction.

5. When the new digitised Method of Measurement (ARMS or other equal and approved) which incorporates the proposed new ICMS Classification has been agreed, this document should be widely publicised within the Construction Sector to the point that Design Professionals will automatically become familiar with and integrate the classifications systems within the BIM Models (similar to the AIA American System) this will then be collaboration working at its optimum.
6. The Professional Bodies in line with the roll out of the NBC Roadmap to Digital Transition need to come together to develop New Standard Templates which are unambiguous for use within the BIM Environment.
7. Both the Professional and Academic Institutions need to collaborate with QS's and devise a 5D QS BIM short practical courses/ workshops/digital on-line courses etc. for the serious skills gap analysis that exists for existing QS's particularly the SME's who lack the expert skills and/or cannot source or afford to buy in these skills in the short term as this will become a must have requirement when the Government mandate BIM

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