“Quantity Surveying Education and the Benchmarking of Future Needs”

Damilola Oluwajoyegbe Ekundayo

PhD by Published Works

University of Salford

School of Science, Engineering and Environment

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# List of Abbreviations

| | |
|---|---|
| AEC | Architecture, engineering and construction |
| AIQS | Australian Institute of Quantity Surveyors |
| APC | Assessment of professional competence |
| BE | Built environment |
| BIM | Building information modelling |
| CBE | Competence-based education |
| CHOBE | Council of Heads of the Built Environment |
| CIOB | Chartered Institute of Building |
| CMF | Competency mapping framework |
| EfS | Education for sustainability |
| EfSD | Education for sustainable development |
| GCTB | Graduate competency threshold benchmark |
| HE | Higher education |
| HEI | Higher education institution |
| PAQS | Pacific Association of Quantity Surveyors |
| PSRBs | Professional, statutory and regulatory bodies |
| QAA | Quality Assurance Agency |
| QS | Quantity surveying |
| RICS | Royal Institution of Chartered Surveyors |
| SD | Sustainable development |
| UG | Undergraduate |
| UoS | University of Salford |

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# Abstract:

The education and development needs of architecture, engineering and construction (AEC) students has received a great deal of attention in recent years. The dynamic nature of the construction industry coupled with the ever-changing needs of clients has put sustained pressure on the AEC curricula of higher education institutions (HEIs). This is exacerbated by the complexities of modern-day buildings/infrastructures and project teams. The education and development needs of AEC professionals have never been more important.

As a vocational subject, the quantity surveying (QS) undergraduate courses delivered in HEIs are designed to prepare students for the world of practice and to deal with emerging challenges (or at least with those intentions). The extent to which graduates from these programmes fulfil this expectation is open to debate and interpretation and continues to generate considerable interest and investigation. The thesis draws upon the wide-ranging perspectives in the field and beyond as the publications were explored from a wider theoretical background and the findings compared with several other important studies.

The main finding associated with vocational QS education is that there is general dissatisfaction with graduate attainments due to a tripartite pull on their training needs. As with APC requirements, defining the levels of attainment of each RICS competency and the extent of training required to cope with the critical challenges and emerging roles in a dynamic industry should inform the development of an adaptable curriculum.

The principal conclusion relating to education for sustainability is that a lack of definition and common agreement on what sustainable development entails is causing different interpretations by HEIs and hindering the development of a structured QS curriculum. A minimum standard which aligns the views of major stakeholders should produce graduates with the required level of knowledge and skills in sustainability.

Regarding BIM education, the critical barriers include the trio of high cost, human factors and inconsistent standards. Despite multi-disciplinary learning, knowledge gaps were found in the collaborative behaviours of QS students. This thesis, thus, concludes that still more needs to be done to move away from the speciality and insularity of the typical BE discipline to the more pluralist and collaborative multi-disciplinary curricula of the future.

# PART A – CRITICAL REVIEW

# Chapter 1: Introduction

## 1.1 Nature of the research and aim

### 1.1.1 Critical review

This thesis has been submitted in partial fulfilment of the requirements of the University of Salford's Doctor of Philosophy (PhD) by Published Works. This PhD by publication presents a body of work relating to understanding quantity surveying (QS) education and developmental needs in the 21st century. There are two parts to the thesis, Part A and Part B. The first part (i.e. Part A) presents a critical review of the published works submitted for the PhD, whilst the second part of the thesis (i.e. Part B) presents a portfolio of those publications which consists of 9 publications and 2 supplementary reports.

Part A, which is the critical review, explores the body of published works individually and collectively in the context of the discipline. Relevant publications are discussed within the three identified themes to help with the alignment of the publications, and the comprehension and readability of the thesis. This allows for reflection on the developmental needs of the QS profession within a broader built environment (BE) context. The work draws upon wide-ranging perspectives in the field and beyond as the publications were explored from a wider theoretical background and the findings compared with other main studies. So, rather than reviewing each publication in isolation, a holistic approach was considered appropriate for the work within the defined parameters. The use of underlining (such as Publication X) has been used throughout the review to maintain the visibility of the individual publications.

### 1.1.2 Nature of the problem/Background to the study

The education and developmental needs of architecture, engineering and construction (AEC) students have received a great deal of attention in recent years. The dynamic nature of the construction industry coupled with the ever-changing needs of clients has put sustained pressure on the AEC curricula of higher education institutions (HEIs). Graduates of these higher education (HE) programmes are expected to become the custodian of the built and natural environments and be capable of designing, constructing, managing, operating, maintaining and taking care of built assets in an increasingly complex environment with dwindling capital and natural resources. This is exacerbated by the complexities of modern-day buildings/infrastructures and project teams. The education and development needs of AEC professionals have never been more important. In fact, such education and development needs have long been a serious bone of contention amongst different groups of stakeholders and have fuelled the continuing education versus training debate, particularly in vocational disciplines.

This ancient, and sometimes cut and thrust, education versus training debate has become a lens through which proponents view the importance of academic rigour and/or the practical relevance of the HE curricula (Hill, Popovic, Eland, Lawton & Morton, 2010; Hill, Popovic, Lawton, *et al.*, 2010; Blair & Serafini, 2016; Palm & Staffansson Pauli, 2018). In an article, Wilson (2010) lamented upon this issue and at the number of people who have ditched the importance of education in favour of more training for technology students at US Universities. Unlike training, which is easy to describe and measure, education can be perceived as abstract. Wilson (2010: 40) asserted that *"training is focussed on narrowly defined operational skills, usually relating to a specific job function or technology"*. Therefore, in the view of Wilson, a real world disconnect exists due to a lack of understanding on the role of HE especially among industry practitioners. Educators must be able to distil fundamentals from transitional knowledge and teach these as well as the requisite basic competencies such as problem solving skills and independent learning skills (Kim, 2006; Hale, 2007; Peach, 2010).

It can be argued that training can be a vital aspect of education because it provides the specific skill sets required to accomplish a task rather than being mere knowledge. This, therefore, uncovers a new debate on whether training should form a key part of education and/or vice versa. According to Blair and Serafini (2016), "Is education training or is training education?" is the cry and a further bone of contention. This idea of reconnecting theory with practice was of utmost importance to Scott *et al.* (2013) in their comprehensive study (which was conducted by several leading scholars and industry practitioners in the built and natural environments). These major academic and industry experts in the field strongly perceived and advocated that education and training should be firmly seated within more pluralist and interdisciplinary curricula in place of the singularity and constriction that is typical of, and which has plagued, most BE programmes and associated professional bodies.

Scott (2016) put forward a rather strong and convincing case for pragmatism in construction education theory and research. It is believed that architecture, engineering and construction is deeply rooted in the pragmatic paradigm (Farmer & Guy, 2010; McKenna & Baume, 2015; Scott, 2016). This philosophical position is based on the practical nature of knowledge in the field of study. According to Scott, the philosophical stance of pragmatism provides the opportunity to understand what construction education really entails and gives the freedom to challenge existing phenomena in order to inform future practice. The role of theory in practice, as well as the essence of education in the training of students in vocationally oriented subjects, ties in with the notion of pragmatist ontology and epistemology which aim to improve practice and solve real life problems (Yin, 2018; Saunders, Lewis, & Thornhill, 2019).

The professional quantity surveyor, being a major actor in the construction industry, has been caught up in an ongoing saga of stakeholder dissatisfaction and continuing tension between industry and academia. Thus, undergraduate construction curricula are constantly under intense scrutiny and continuous modernisation to keep abreast of developments in the industry and to satisfy the needs of various stakeholders including professional bodies, practitioners and students alike. As a vocational subject/discipline, the QS undergraduate courses delivered in HEIs are designed to prepare their students for the world of practice and emerging challenges (or at least with that intention). The extent to which graduates of these programmes fulfil this expectation is open to debate and interpretation and continues to generate considerable interest and investigation. The gap in expectations between academics, industry practitioners and professional bodies is brought into sharp focus as the order of the day seems to be confusion and dissatisfaction, leading to disgruntled and incapable graduates confronting evolving roles who do not meet stakeholders' expectations, as explicated in Publications 1, 2 and 3.

Perhaps we should trust, unquestioningly, our education providers and HEIs as beacons of knowledge and centres of excellence, or associated professional bodies as regulators which set the pace for the development of QS vocational learning. Maybe industry practitioners with current real-life experiences, as pacesetters, should take the lead, or possibly students (who are the future practitioners and leaders themselves) should be given more say on their learning and put in charge of their destiny. Irrespective of the favoured school of thought, the one thing that is certain in all of this is that a healthy academia-industry-professional body nexus is a relevant proposition for unifying the perceptions and expectations (and thus satisfaction) of the various stakeholders involved.

### 1.1.3 Aim

The principle aim of this thesis is, therefore, to investigate the development of QS undergraduate programmes in order to better prepare students (who meet stakeholders' expectations) for practice. The aim is achieved through an evaluation of three major themes which can be distilled from the published works submitted in the thesis, as follows:

- the nature of vocational/professional education and the alignment of the views of various stakeholders on RICS QS competencies;
- the nexus between sustainable development and the construction industry as evident in academic journals, QS education and practices;
- the significance of building information modelling (BIM) integration and multi-disciplinary learning in programme curricula within higher education.

In brief, the works examine three aspects of QS education and development needs relating to the Royal Institution of Chartered Surveyors (RICS) QS competencies (Publications 1, 2 and 3), sustainability knowledge areas (Publications 4, 5 and 6) and BIM/multi-disciplinary learning (Publications 7, 8 and 9). The thesis focuses on each of these aspects within chapters 2, 3 and 4.

## 1.2 PhD by Published Works

### 1.2.1 Descriptor for a Level 8 qualification: Doctoral degree

A PhD by published works thesis requires a retrospective approach to the overall narrative and has to draw on several individual research projects, unlike a traditional PhD thesis (Wood, 2012; Fitton, 2016). This thesis demonstrates the core skills and competencies that have been developed by the researcher to achieve a PhD by publication. Using the approach adopted in Wood (2012), and to help the reader, the following sub-sections provide a preliminary sketch of the combined body of work submitted in the nine publications, and how they fully meet the requirements of the qualification descriptor for a Doctoral degree as defined by the Quality Assurance Agency (QAA, 2014). These requirements, as stated within the QAA framework for higher education qualifications, are:

- the general ability to conceptualise, design and implement a project for the generation of new knowledge, applications or understanding;
- a systematic acquisition and understanding of a substantial body of knowledge which is at the forefront of an academic discipline or area of professional practice;
- a detailed understanding of applicable techniques for research and advanced academic enquiry, and
- the creation and interpretation of new knowledge, through original research, of a quality to satisfy peer review, extend the forefront of the discipline, and merit publication.

### 1.2.2 Conceptualising, designing and implementing a research project

Much of the research that has led to the portfolio of publications submitted for this thesis required formulating a research problem, coming up with appropriate research questions and objectives, and devising an implementation strategy on the part of the researcher. For example, with reference to Publication 4, *Mapping Sustainability in the QS Curriculum*, the research problem was conceptualised by the researcher, as well as the planning and execution of the project. The broad theme for the research that led to Publications 2 and 3 was originally defined by a RICS Research Trust call out, however the bid was submitted in competition with other researchers. This particular research still required the streamlining of the research problem, the framing of the project goals and the overarching aim, and the development of the methodological approach and planning its implementation. The ability to do this led to the generation of new knowledge (see section 1.2.5), and the project design was occasionally adjusted in the light of unforeseen problems.

### 1.2.3 Acquisition and understanding of a substantial body of knowledge

The works have involved a critical review and evaluation of a substantial body of literature to address the identified subject matter and areas. This involved searching and analysing some 420 academic papers, industry reports and other publications. A comprehensive understanding of the varied and existing work in the field frequently led to the identification of a gap in knowledge that required further investigation and/or analysis. Also, within the body of work presented, the analysis of some issues and advanced scholarship from within Publication 1 led to Publications 2 and 3, whilst the need for further academic inquiry from Publication 4 resulted in Publications 5 and 6 respectively. New research problems were formulated, and fresh data were collected, in the portfolio of publications to address the perceived gap(s) in knowledge and to provide a more accurate picture of current phenomena. The new insights gained from the reviews and evaluations ensured that this body of work is at the forefront of academic discipline and the associated area of professional practice. Additionally, the implications of the reviews and evaluations for academia and industry were subsequently explored.

### 1.2.4 Understanding of the applicable research techniques

The research philosophy which is mostly adopted in the published works is pragmatism. This philosophical position is based on the practical nature of knowledge in the field of study. Scott (2016) put forward a rather strong and convincing case for pragmatism in construction education theory and research. According to Scott, the philosophical stance of pragmatism provides the opportunity to understand what construction education really entails and gives the freedom to challenge existing phenomena in order to inform future practice. The role of theory in practice, as well as the essence of education in the training of students in vocationally oriented subjects such as quantity surveying, is vital to this philosophical underpinning.

Whilst there may be other applicable research philosophies, it is believed that architecture, engineering and construction is deeply rooted in the pragmatic paradigm (Farmer & Guy, 2010; McKenna & Baume, 2015; Scott, 2016). The need to investigate the problems within current QS practice and education in view of the future industry requirements has informed the chosen pragmatic framework. This ties in with the notion of pragmatist ontology and epistemology which aim to improve practice and solve real life problems (Yin, 2018; Saunders *et al.*, 2019). In accordance with this philosophical underpinning and the exploratory nature of the research, the published works used a variety of research strategies, *inter alia*, case study and survey. The exploratory case study approach enabled an in-depth enquiry and a deeper understanding of the existing phenomena in a real-life context (Creswell, 2009; Yin, 2018).

The nine publications submitted demonstrate a detailed understanding of applicable techniques for research and advanced academic enquiry. Based on the nature of the investigation in each individual study and the associated research strategy, appropriate instruments were used for data collection and analysis. Triangulation, which according to Creswell (2009) involves using more than one method or a variety of methods to collect data on the same subject matter, in a qualitative research, was sometimes used to develop a broad understanding of a phenomenon and/or to investigate the same thing.

The attitudes, perceptions, views, experiences and expectations of relevant stakeholders on various issues relating to academia and industry were collected through a series of semi-structured interviews carried out with 50 experts. The qualitative and quantitative data within the nine publications were also collected from a total of 16 detailed competency mapping case studies that were conducted, and from the 661 sets of fully completed survey responses received. Those responding to the questionnaire surveys, and the expert forum participants, comprised RICS officials, academics, students and practitioners in the field of study.

The NVivo computer software package was used for organising and processing and for content analysis of the qualitative data generated from the semi-structed interviews, whilst the quantitative data in the works were analysed and presented using relevant inferential and descriptive statistics. Descriptive statistical analysis was used to devise a detailed map scoring system for the competency mapping case studies using a two-dimensional matrix and scale. Using the Delphi technique explicated in Keeney (2011), the views of the expert forum participants were extracted and harmonised to produce a Graduate Competency Threshold Benchmark (GCTB).

Table 1 provides a summary of statistics which gives a snapshot of the combined scope of the work included.

*Table 1: Profile of publications*

| Publication | References | Mapping case studies | Semi-structured interviews/ Expert forum (participants) | Questionnaire responses | Citations (Google Scholar) |
|---|---|---|---|---|---|
| **1** | 35 | 4 | 10 | 0 | 10 |
| **2** | 51 | 0 | 10 | 346 | 7 |
| **3** | 37 | 4 | 15 | 0 | 20 |
| **4** | 49 | 4 | 15 | 0 | 2 |
| **5** | 49 | 0 | 0 | 87 | 11 |
| **6** | 32 | 4 | 0 | 0 | ? |
| **7** | 79 | 0 | 0 | 100 | 10 |
| **8** | 68 | 0 | 0 | 99 | 5 |
| **9** | 21 | 0 | 0 | 29 | N/A |
| **Total** | 421 | 16 | 50 | 661 | 65 |

### 1.2.5 Creation and interpretation of new knowledge and originality of research

The nine publications submitted are from original research which demonstrates advanced scholarship of a quality that has satisfied peer review. Before being accepted for publication, the works were subjected to a double-blind peer review by independent expert referees and subject matter experts, as per the norm in the field. The work includes one publication (i.e. Publication 9) that has been accepted for publication and is now in the production stage. The remaining eight publications included have produced around 70 citations in other academic journals and texts, even though several of the papers have only been published 1-3 years ago. These publications have identified gaps in the existing literature and have attempted to fill these gaps by conducting primary research that corroborates or refutes existing knowledge and adds to the body of knowledge in a way that extends the forefront of the QS discipline at a national and international level.

For example, the research project into Competence-based Education (Publications 1, 2 and 3) has been used to maximise the RICS' global policy in QS education such as the recommendation to have a benchmark level of achievement of competencies for graduate QSs. Also, this research project has had a direct impact on the periodic programme review of the undergraduate QS programme at Northumbria University, to determine its academic health and ensure its continuing currency and industry-relevance.

Similarly, based on knowledge from the research into Education for Sustainability (Publications 4, 5 and 6), an aspect of environmental sustainability was introduced into the design economics module taught to final year QS students at Northumbria University. In addition, the research published in Publications 7 and 8 on BIM has provided impetus for the development of QS undergraduate curricula in a developed and developing country context, whilst the research project into multi-disciplinary learning in Publication 9 is helping to provide continued support for collaborative learning approaches and in developing the key skills required on a multi-disciplinary project module undertaken by all BE students at the University of Salford.

## 1.3 Currency and coherence

As defined in the University of Salford (UoS) Academic Regulations for Research Awards, the claim for PhD by Published Works is normally based on 5 – 8 publications. More than the minimum number of publications required are included because of their relevance to the overarching aim and key themes of this thesis. The regulations also require that these publications should not have been published more than 10 years before the date of registration of candidature (September 2019). This implies that published work going back to 2009 can be included in the claim. However, apart from the works published in 2013 (Publication 1) and 2015 (Publication 4), the remaining works have been published only recently. This shows the timeliness, currency and relevance of the body of work to the subject matter addressed in the thesis. The publications, through the questions posed and the findings presented, also provide contemporary and fresh perspectives on the age-old ongoing debate about professional education in general and the QS discipline in particular.

*Table 2: Outline of the work presented*

| ***QS Education/Development Needs*** | | |
|---|---|---|
| ***Competence-based Education (Publications 1-3)*** | ***Education for Sustainability (Publications 4-6)*** | ***BIM & Multi-disciplinary learning (Publications 7-9)*** |
| 1. Professional, academic and industrial development needs: A competency mapping and expert opinion review<br><br>2. Professional competency-based analysis of continuing tensions between education and training in higher education<br><br>3. Competency mapping framework for regulating professionally oriented degree programmes in higher education | 4. Mapping sustainability in the quantity surveying curriculum: Educating tomorrow's design economists<br><br>5. Sustainable development in a construction related curriculum – quantity surveying students' perspective<br><br>6. Towards the development of a framework for incorporating sustainability education in the built environment curriculum | 7. Analysis of the drivers and benefits of BIM incorporation into the quantity surveying profession: academia and students' perspectives<br><br>8. Barriers to the incorporation of BIM into quantity surveying undergraduate curriculum in the Nigerian universities<br><br>9. Collaborative multi-disciplinary learning – quantity surveying students' perspective |

As shown in Table 2, the body of work submitted explores the education and development needs of quantity surveyors through the *lens* of: competence-based education (Publications 1, 2 and 3), education for sustainability (Publications 4, 5 and 6), and BIM/multi-disciplinary learning (Publications 7, 8 and 9). Table 3 gives a summary as to which of these three strands of QS education and development needs are explored in each publication. It would be misleading, or at best tempting, to assume that the publications submitted as well as the critical review in Part A provide an exhaustive body of work in this regard. Nevertheless, and as previously mentioned, the works contribute to the ongoing training versus education debate in vocational disciplines, albeit with a QS focus and bearing in mind the future industry needs and employer demands. The aim here is an understanding of, and the alignment of, academic and industry views on the attainment and expectations of QS graduates so as to develop undergraduate programmes that meet the requirements and needs of the various stakeholders without compromising the ability of the curriculum to adapt to ever-changing demands. The discussions in the publications and the critical review are thus relevant and necessary if academic integrity and sanity, student employability and satisfaction, as well as industry input and engagement are to be preserved, encouraged and sustained. This relates not only to QS but to all disciplines in the AEC/BE sector and to all subject areas in the vocational domain.

*Table 3: Themes of publications*

| Publication | Relationship |
|---|---|
| **1** | Competence-based Education |
| **2** | Competence-based Education |
| **3** | Competence-based Education |
| **4** | Education for Sustainability |
| **5** | Education for Sustainability |
| **6** | Education for Sustainability |
| **7** | BIM & Multi-disciplinary Learning |
| **8** | BIM & Multi-disciplinary Learning |
| **9** | BIM & Multi-disciplinary Learning |

## 1.4 Summary

This chapter provides a general overview of the thesis, the nature of the problem investigated, and the aim and principal themes of the 9 publications submitted. It also demonstrates how this body of work addresses the requirements of both the UoS academic regulations for PhD by publication and the QAA qualification descriptor. In brief, the published works examine three aspects of QS education and developmental needs relating to the RICS QS competencies (Publications 1-3), sustainability knowledge areas (Publications 4-6) and BIM/multi-disciplinary learning (Publications 7-9). The thesis focuses on each of these aspects within chapters 2, 3 and 4, as follows.

# Chapter 2: Competence-based Education

## 2.1 Introduction

Competence-based education (CBE) can be regarded as an approach to education that encourages the use of a more practical, outcome-focused curriculum particularly in vocational subjects. The emphasis of CBE is on the development of technical skills and the professional competencies required to function successfully in a designated field (Winter & Maisch, 1996; Pashchenko & Vanina, 2019). Based on constructivism, which is characterised by knowledge construction, CBE focusses on authentic learning, problem-based learning and the validation of prior learning through knowledge application. CBE is an educational concept that is competence-based, and academic curricula are developed using competencies that will help to prepare students for practice.

This is in sharp contrast with the more traditional forms of education which emphasise academic knowledge accumulation and deep understanding. While CBE is emerging due to the disconnection between traditional education and what the industry needs, concerns exist as to its successful implementation. Findings from research such as that undertaken by Koenen, Dochy and Berghmans (2015) show that a blend of CBE and traditional methods is starting to gain traction in programme design and curriculum development. Morel and Griffiths (2018) in their book on refining CBE went further to suggest that interpersonal, cross-cutting and non-cognitive skills as well as the ability to adapt and cope in any professional setting should be a key part of CBE in the twenty-first century. "*Competence for life*" is the umbrella term used by Morel and Griffiths (2018) to encapsulate these soft skills that will serve a graduate well in any profession throughout their lifetime. Simply put, this is a marriage between the trio of traditional education (based on general knowledge/skills), training (based on practical competencies/skills) and multi-disciplinary learning (based on collaborative/non-cognitive skills).

Publication 2 contributes to the definition and notion of CBE as well as to the role of assessment in this. Surely, assessment for learning in a work-based environment or using a problem-based scenario is a catalyst for developing required competence. Hill, Popovic, Eland *et al.* (2010) compared this to creating future-proof graduates using scenario-based learning. The study in Publication 2 provides an indication that the definition of competence covers the mix of knowledge, skills, abilities, behaviours and attitudes required to do a job or task effectively and efficiently. The review in this particular study shows that whilst there are clear benefits of CBE, its adoption is equally driven by the awareness of, and the need for, HEIs to comply with professional body requirements and industry practice in the design and delivery of programmes to gain necessary accreditations. Also, with the mass production and supply of graduates to the market (Scott, 2015), employers' demands are starting to have a significant bearing on the development of undergraduate curricula in order to maintain their relevance and improve graduate employability in the fast-changing, competitive work environment. Publication 2 uncovers that CBE as an integrated approach has not been successfully implemented in higher education and the reasons for this failure and the imperfections of CBE are discussed in more detail later in this chapter.

CBE has been under sustained critique and scrutiny for some time now. Indeed, the "*competence for life*" perspective put forward by Morel and Griffiths (2018) deviates somehow from the norm in vocational education. Fast-forwarding to the current decade, CBE is still a topic of much discourse because it is seen as a way of integrating education with training, and theory with practice. It is often perceived that there is a gap between what higher education provides and what the industry needs, hence the development in CBE to improve connectivity (Schaap, de Bruijn, Van Der Schaaf & Kirschner, 2009; Hill, Popovic, Eland *et al.*, 2010; Hill, Popovic, Lawton *et al.*, 2010; Wesselink, de Jong, & Biemans, 2010; Morel & Griffiths, 2018; Palm & Staffansson Pauli, 2018).

With industry requirements remaining the central focus here, Edwards (2016) asserted that CBE can lead to a narrowly defined curriculum where the deep knowledge and understanding integral to academic inquiry and intellectual curiosity are side-lined. The subsequent sections in this chapter, therefore, seek to explore the education versus training debate typical of CBE; the RICS' QS competency requirements; the mechanisms for appraising and benchmarking in this area of practice, as well as the alignment framework for closing the gap between what universities provide and what employers want. To this end, reference will be made to wider disciplinary perspectives and the literature, including the publications submitted in this thesis.

## 2.2 The education versus training debate

The seemingly insoluble conundrum of education and/or training continues to dominate pedagogy discussions and CBE. This ancient, and sometimes cut and thrust, education versus training debate has become a lens through which proponents view the importance of academic rigour and/or the practical relevance of the HE curricula. In an article, Wilson (2010) lamented regarding this issue and at the number of people who have ditched the significance of education in favour of more training for technology students at US Universities. Unlike training, which is easy to describe and measure, education can be perceived as abstract. Wilson asserts that *"training is focussed on narrowly defined operational skills, usually relating to a specific job function or technology"*. Such an operational skill could be learning a specific programming language to hit the floor running with certain technology graduate employers. The essence of education, on the one hand, must be to produce intelligent graduates that are highly flexible and adaptable (for example, equipping students with the fundamental knowledge and an enduring understanding of programming, so they can demonstrate to any future employer that they can apply themselves well to any language). On the other hand, vocational training mainly involves aspiring to meet the learning outcomes of an academic curriculum through the achievement of specific job competencies at the required levels (Beckman, Coulter, Khajenoori & Mead, 1997; McHardy & Allan, 2000; Gibbs, Brigden, & Hellenberg, 2004).

Assessment of competencies for learners in vocational subjects, typical of CBE, emanated from the concept of training. Indeed, if HEIs are not teaching fundamental knowledge and specific skills which are germane to professional practice, an academic programme will soon be outdated and archaic. So, surely university curricula must involve some elements of training to be valid and to maintain their academic health, currency and relevance. This was also the view in the research conducted into medical education by Gibbs *et al.* (2004). But whether all aspects of training relating to a discipline can be covered in an academic curriculum is another issue, which is open to contentious debate and varied interpretation. If the answer is no, then does this reflect badly on our education system? The response from Wilson (2010) is of course not, on the premise that vocational learning is a lifelong endeavour. A real world disconnect, in the view of Wilson, exists, therefore, due to a lack of understanding about the role of HE especially among industry practitioners. Our educators must be able to distil fundamentals from transitional knowledge and teach the former as well as the requisite basic competencies, the problem-solving skills and the independent learning skills (Kim, 2006; Hale, 2007; Peach, 2010).

As reported in Wood (2012), a study which investigated research, practice and education in the built environment, some educators, perhaps in the minority, still believe though that training is best (and only) picked up in the workplace through placement and the like, or during a person's professional career. This view must be gravitating towards extinction (Morel & Griffiths, 2018) as it is based on a limited understanding of what education entails. On the contrary, Garcia (2008) pointed out the growing perception among pedagogy scholars that specific competencies and skills can be taught through vocational and practical education. Clearly, HEIs can do much more by teaching practical skills and knowledge in a working environment context. Interestingly, the afore-mentioned author is of the opinion that research and theoretical knowledge relevant to a specialism should be construed as training, and thus he argued that education should focus on academic enquiry, deep understanding, applied research and associated skills, believing that the relevant job-related competencies can be gained in, and through, employment.

It is rather perplexing and perhaps invigorating to see a strong case being made in favour of more education rather than training from a practitioner viewpoint. Even though the importance of training is never discredited in Garcia's article most failures in the fire service industry, which is the focus of his study, were attributed to the inadequate educational background of the firefighters and their lack of ability to think outside the box (i.e. beyond their training). This is precisely why Garcia, an engineering contractor and employer, would rather work with a conventionally educated professional capable of innovating and of challenging the norms than a dogmatic well-trained individual.

Earlier, Cross (1996) made a vivid illustration of the clear difference between training and education using the following analogy: if your teenage girl informs you of a course on sex education that she would be undertaking at school, you might be satisfied with this, right! However, what if your young teenager declares that she will be participating in some sex training instead…? A person's reactions to Cross's illustration above, which makes perfect sense hopefully, are rooted in, and guided by, the apparently distinct differences between the two subjects, education and training. Education entails learning the general facts, concepts, values, history and theory in the field of study, which together help to build a person's foundation or knowledge base and behaviour; hence, Blair and Serafini (2016) maintained that education can help to develop the cognitive skills required to flourish intellectually. Training, which is often regarded as learning by doing, is where the general knowledge gained in the chosen field is taken to the next level and applied to practical and job-related competencies (Hill, Popovic, Eland *et al.*, 2010; Hill, Popovic, Lawton *et al.*, 2010; Blair & Serafini, 2016; Palm & Staffansson Pauli, 2018).

Training, which is based on practising and mastering the defined competencies at the appropriate levels, can be viewed as a routine learning approach that uses an acquired skill set to demystify practical known tasks and probable issues. Education, which can be considered as a dynamic learning approach, is more exploratory since a deep understanding of a subject helps to create guiding principles which help to solve unknown problems and provides assistance when entering uncharted territories. One key difference between these two subjects is, therefore, the present nature of training and the future approach of education. Another distinct difference is the focus of training and of education. In the case of the former, educators provide a work-related environment for learners to master specific skills whilst in the later learner autonomy and self-discipline is taught and encouraged.

In view of the above, it can be argued that training can be a vital aspect of education because it provides the specific skill sets required to accomplish a task rather than being mere knowledge. This, therefore, uncovers a new debate on whether training should form a key part of education and/or vice versa. "Is education training or is training education?" is the cry and a further bone of contention. Regardless of the preferred school of thought, an integrated training and education approach to undergraduate curriculum development remains the common denominator for most scholars in the field. What we cannot and must not do is to take a literal, single-dimensional view of education and training.

In the words of Garcia (2008):

*"We must have a deliberate mix of education and training to teach not only the How (training) but also the When, Why, and Why Not (education)".*

This idea of reconnecting theory with practice was of utmost importance to Scott *et al.* (2013) in their comprehensive study (which was conducted by several leading scholars and industry practitioners in the built and natural environments). These major academic and industry experts in the field strongly perceived, admonished and advocated that education and training should be firmly seated within more pluralist and interdisciplinary curricula rather than the singularity and constriction that is typical of, and which has plagued, most BE programmes and associated professional bodies.

Whilst the words education and training are sometimes used interchangeably, many proponents believe that training is part of education and they complement each other (Beckman *et al.*, 1997; Bishop, 1998; Gibbs *et al.*, 2004; Hale, 2007; Wilson, 2010; Blair & Serafini, 2016). Education, according to Gibbs *et al.* (2004) includes training, information acquisition and initiation as well as thinking and problem-solving skills. Consequently, some authors (Schaap *et al.*, 2009; Peach, 2010) have suggested the replacement of training with vocational education as an all-encompassing and a more fitting term to reflect the desired attitude and approach to curriculum development whilst others have argued that education and training should happen simultaneously rather than being treated as antonymous as reported in Malamud and Pop-Eleches (2008) and Wood (2012). This is particularly important in certain vocational subjects and disciplines such as for doctors, nurses, lawyers and pilots where the prospect of educated professionals with NO training is daunting and frightening, at best.

In the spirit of pluralism, creating an academic curriculum integrating both training and education will result in a focussed experiential emphasis rooted in broader academic learning and critical thinking skills (Kim, 2006; Scott *et al.*, 2013). This judgement led Hale (2007) to the assertion that while training is essential, this should not be at the cost of education. Universities should, therefore, remain as a citadel of knowledge and creativity (rather than a mere training camp) underpinned by intellectual dialogue and applied research. A socially critical vocationalism (SCV) is the slogan used to define this HE curriculum philosophy in Peach (2010). According to Peach, this is an academically justifiable, experientially focussed and socially dynamic approach to curriculum development that will go a long way to resolve the tensions caused by the pedagogy debates. As its name indicates, experientially focussed education affirms the importance of training, real tasks and practical experience within learning and development in HE

(Kolb, 1984; Healey & Jenkins, 2000), particularly with regard to BE vocational disciplines (Shelbourn, Aouad, Hoxley & Stokes, 2000; Shelbourn, Aouad & Hoxley, 2001; Shelbourn, Hoxley & Aouad, 2004). Such education is critical to HE survival and to the successful marketing of UG programmes which have a broader societal, industry and student appeal.

Aligned to this debate, Publication 1 investigated the current and future needs of quantity surveyors who satisfy the aspirations of various stakeholders. The study found that the development needs of quantity surveyors are pulled in opposite triangular directions by three different groups of stakeholders, namely academics, industry and professional bodies. Further to the conflicting needs of the academic and industry stakeholders as evident in the studies above, Publication 1 adds to the pedagogical debates through the lens of construction programmes, but with the added dimension of professional body expectations such as those of the RICS, arguably the most relevant body that accredits Bachelor’s with honours QS degree courses in the UK and which has the most influence on QS education globally (RICS, 2019). In addition, RICS, which is perceived to send conflicting messages to industry and academia, is also interested in graduates that can quickly progress to chartered membership status by passing the assessment of professional competence (APC) within a few years of graduation (RICS, 2018a). A major finding of Publication 1 is that the RICS accredited QS undergraduate courses are not fit for purpose due to the tripartite pull. This culminates in less than satisfied graduates who are perceived as not fulfilling expectations thereby causing dissatisfaction on the part of the employer whilst HEIs are being dragged from pillar to post. The results of the research discussed in Publication 1 indicate that the varying, and increasingly divergent, demands from the three major group of stakeholders are the catalyst for the education versus training debate and the resulting tension and discontent in the construction industry. If nothing else, we must listen to the call for the better integration of subject knowledge, academic skills and practical skills’ training in the design and development of the QS undergraduate education system.

## 2.3 RICS QS competency requirements

The construction industry is one of the most valuable sectors contributing to the wealth and prosperity of a nation (Yogeshwaran, Perera & Ariyachandra, 2018). The activities of this vast industry help to build facilities and maintain infrastructure which are considered to be the pillars and bedrock of developed nations. A successful and invigorated construction industry is also capable of delivering the much-needed changes in the built environment of emerging and developing countries; hence, the importance of BE education to the economic growth and development of a country. Participants in the construction industry are wide-ranging and they include, among others, architects, planners, surveyors, engineers, managers, and archaeologists. Together, they help to deliver a responsible and healthy built environment fit for the future (Crafford & Smallwood, 2007). These disciplines and areas of practice inform the development of AEC/BE courses at both undergraduate and postgraduate levels in higher education, for example, Urban and Regional Planning, Architecture, Building Technology, Land Surveying, QS, Civil Engineering, Construction and Project Management, etc.

QS is a profession that is well established in the UK and in certain British Commonwealth developed countries (such as Australia and New Zealand) and developing countries (such as Sri Lanka, Malaysia and Nigeria etc.). As Nkado and Meyer (2001) put it, a quantity surveyor is part of the BE disciplines and an important member of the construction industry globally, involved as a consultant in a private practice (often termed a PQS) or as the commercial expert with a contracting organisation (often termed the CQS). They can be seen working, either as cost engineers, construction economists or cost managers (Male, 1990), in the real estate, heavy engineering and infrastructure sectors.

To be competent as a professional quantity surveyor is to have the skill sets and ability to manage the overall cost of a project or facility from cradle to grave, that is, whole life. Such competencies may include their involvement in development appraisals and feasibility studies, procurement and tendering, cost planning, control and commercial management as well as other duties (such as dispute resolution, value engineering, risk and facility management among others) (Crafford & Smallwood, 2007; Owusu-Manu, Edwards, Holt & Prince, 2014; Shafie, Syed Khuzzan & Mohyin, 2014; Yogeshwaran *et al.*, 2018). In addition, a professional quantity surveyor's expertise is often valued during the capital expenditure (CAPEX) phase, the operational expenditure (OPEX) phase and even during the demolition phase of a development (RICS, 2018a).

The skills, knowledge and experience required of a qualified surveyor are defined by the RICS. To enter the QS profession (which requires the successful completion of the assessment of professional competence (i.e. APC)), candidates must be competent to practice and to achieve a set of requirements in relevant technical and professional practice, management, business and interpersonal skills (RICS, 2018b). Whilst some of these required competencies are generic in nature and apply to several fields of practice in the built environment and beyond, the technical competencies are QS and construction focussed. These competencies, which form the basis of QS education and training in HE, are achieved through a mix of academic knowledge, professional practice and relevant experience.

RICS (2018a)'s pathway guide for QS and construction presents the competencies required for this area of practice, in order to qualify through the pathway. The guide also sets out in detail examples of the plausible experience, skills and knowledge required by an APC candidate to demonstrate the competencies. These competencies have been grouped into three different categories, and the three levels of attainment of each competency, as defined by RICS (2018b), are thus:

- Level 1 is having knowledge and understanding;
- Level 2 is the application of the knowledge gained;
- Level 3 is the ability to give reasoned advice and implement synthesised and in-depth technical knowledge.

The three categories of competencies (RICS, 2018b) are:

- Mandatory competencies such as generic interpersonal, personal, business and professional practice skills;
- The technical core such as the main "QS and construction" skills;
- Technical options which include some other designated skills relevant to QS practice (e.g. sustainability, risk management, programming and planning).

Figure 1 provides a summary of the QS and construction competency requirements and gives a snapshot of the expected level of competency achievement for an APC candidate to become qualified as a chartered member of the RICS. Although APC can now be completed without structured training by very experienced candidates with significant (typically more than 10) years of experience working as a quantity surveyor, APC is usually undertaken via a 24-month structured training (typically for recent QS graduates with under five years of experience) or a via a 12-month training (for those with over five years of experience), post qualification or graduation, which ensures candidates are competent before sitting the final assessment. The former (the 24-month structured training) is usually undertaken by recent graduates with a Bachelor's degree from RICS accredited programmes. The RICS has many sector pathways covering diverse fields of practice which allow participants to specialise and become qualified. But the "QS and construction" pathway is the most aligned in terms of reflecting the knowledge, skills and experience gained through QS education and training.

### Mandatory competencies

**Level 3**

- Ethics, Rules of Conduct and professionalism

**Level 2**

- Client care
- Communication and negotiation
- Health and safety

**Level 1**

- Accounting principles and procedures
- Business planning
- Conflict avoidance, management and dispute resolution procedures
- Data management
- Diversity, inclusion and teamworking
- Inclusive environments
- Sustainability

### Core competencies

**Level 3**

- Commercial management (of construction works) **or** Design economics and cost planning*
- Construction technology and environmental services
- Contract practice
- Procurement and tendering
- Project finance (control and reporting)
- Quantification and costing (of construction works)

### Optional competencies

**Two to Level 2**

- Capital allowances
- Commercial management (of construction works) **or** Design economics and cost planning (whichever is not selected as core competency)
- Conflict avoidance, management and dispute resolution procedures **or** Sustainability
- Contract administration
- Corporate recovery and insolvency
- Due diligence
- Insurance
- Programming and planning
- Project feasibility analysis
- Risk management

* Candidates working in a **commercial or contracting environment** will likely choose **Commercial management to Level 3**.

Candidates working in a **consulting environment** within either the public or private sector will likely choose **Design economics and cost planning to Level 3**.

*Figure 1: RICS QS and construction pathway requirements (RICS, 2018a)*

Yet, the findings of several studies (Nkado & Meyer, 2001; Perera & Pearson, 2011; Shafie *et al.*, 2014; Shayan, Kim, Ma, Freda & Liu, 2019) from around the world, including the UK, reveal a "competency gap" in the skills of graduate quantity surveyors produced by these academic institutions which carry an RICS Accreditation. Likewise reports exist that discuss the mismatch between the actual, expected and perceived level of achievement of competencies by graduate quantity surveyors, based on the views from employers, academics and the graduate themselves (Crafford & Smallwood, 2007; Hassan, Ismail, Zaini, Hassan & Maisham, 2011; Yogeshwaran *et al.*, 2018). In the study by Shafie *et al.* (2014), the competency gap is between the skills' performance of QS graduates and the expectations of their employers. In this study the QS graduates produced by Malaysian HEIs are considered by employers to be particularly lacking in generic mandatory competencies such as personal and interpersonal skills.

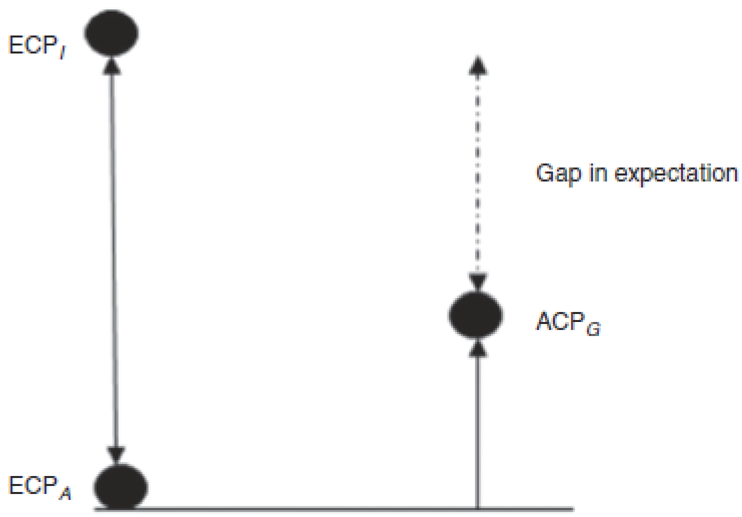
In their widely cited study on professional QS competencies, conducted in South Africa, Nkado and Meyer (2001) reported a significant gap between practitioners' current attainment levels and the desired proficiency levels in the identified competencies. The study which produced a damning self-appraisal of practitioner proficiency levels concluded, based on the findings, that the present QS education and training system in South Africa is not capable of producing graduates that can satisfy current employers' wants and future industry needs. A similar study by Yogeshwaran *et al.* (2018) in Sri Lanka exposed the deficiency of QS education there and how it does not live up to expectations in terms of graduate competency attainments. This study identified a mismatch between QS graduate competencies and industry expectations. Whilst a few competencies were achieved at levels above industry expectations, the proficiency levels for most competencies were below industry needs.

In a recent comprehensive study which examined the emerging challenges and the future role of quantity surveyors, Shayan *et al.* (2019) asserted that competencies in sustainability and BIM are of paramount importance. An earlier, but also recent, study on the industry's competency expectations of QS graduates by Yogeshwaran *et al.* (2018) affirmed the same point, and asked for these competencies to be given utmost priority in curriculum development. This is because, nowadays, the adoption of BIM and sustainability can be pointed out as the two most important factors in the construction industry worldwide. Yogeshwaran *et al.* (2018) maintained that the quantity surveyors of the twenty-first century must possess specialist knowledge and the ability to advise on sustainability issues regarding development and construction, and on BIM for cost management. The above study which involved participants from regulatory professional bodies like RICS, the Australian Institute of Quantity Surveyors (AIQS) and the Pacific Association of Quantity Surveyors (PAQS), amongst others, provided useful insights into challenges and the competencies required for quantity surveyors to cope in the competitive, modern construction industry.

Unlike the QS competency requirements expected by RICS (2018a) and RICS (2018b), which only have a subtle emphasis on (and references to) an advisory ability on sustainability and BIM (under generic competencies), Yogeshwaran *et al.* (2018) and Shayan *et al.* (2019) disclosed that these two specialist knowledge areas (dubbed as future competencies in keeping with the global trend) should be treated as technical core and primary QS skills. Essentially, further knowledge and experience in these subjects are germane to meeting the future needs and demands of a dynamic, multi-disciplinary construction industry, and the undergraduate QS curricula of HEIs must be developed to reflect this. This is precisely why “education for sustainable development” as well as “BIM and multi-disciplinary learning” are explored in subsequent chapters. The findings of the publications included in this thesis would appear to mirror the above view and reinforce the need for pedagogical diversification and continued curricula development.

The contributions that the publications submitted here have made to this debate relate to a gap analysis in the undergraduate QS curricula of academic institutions in the UK, which is relatively underresearched. Despite RICS guidance, HEIs in the UK still design and deliver their QS courses differently, thus leading to graduates bringing different levels of competencies into the workplace which confuses employers and causes dissatisfaction. For example, in Publication 2 we learn that there is no defined and/or agreed levels of competency attainment for QS graduates in RICS accredited institutions in the UK. This assertion has been supported in the study by Yogeshwaran *et al.* (2018) which examined the RICS accredited programmes in Sri Lanka. Both Publication 2 and Yogeshwaran *et al.* (2018) agreed, at that time, that although the RICS has listed the competencies, it has yet to define the proficiency levels that have to be achieved by graduate quantity surveyors of accredited institutions.

Following on from Publication 1 which reveals tension and dissatisfaction in the education and training of quantity surveyors as a result of a tripartite pull on QS development needs, in Publication 2 we find a perception gap between industry and academia, as illustrated in Figure 2. This RICS-funded study included a comprehensive survey of nearly half of all the UK registered RICS chartered quantity surveyors working in client, contracting and consultancy organisations in both the public and private sectors as well as a survey of academics from all 26 HEIs which offer RICS accredited courses in the UK. The responses from the industry experts indicated the unreasonably high expectations that the construction industry has in terms of QS graduates achieving 'APC level' proficiency in all mandatory, technical core and several optional competencies. Contrasted with the academic responses, this shows a big gap in stakeholders' expectations regarding the level of achievement of competencies for a new graduate. The industry survey further indicated that employers are not reasonably satisfied with the competencies achieved (i.e. competency attainment) by the current crop of QS graduates. The study thus establishes, through empirical evidence, the mismatch that exists between the importance attached to a competence and the relatively lower level of attainment, as well as the mismatch between academic views and industry perceptions on the ranking of importance, and the expected level of achievement, of competencies.




**Notes:** ECP, expected competency profile; ACP, actual competency profile; *I*, industry; *A*, academia; *G*, graduate; …… perception gap

*Figure 2: Perception gap in graduate competency (Publication 2)*

On the one hand, this suggests that the industry may be ill-informed or does not understand the role of educators in producing well-rounded graduates who require further training before they become fully fledged surveyors. On the other hand, it appears that employers, as a key stakeholder group involved in the training of QS graduates, might be ducking their responsibilities in the highly-pressured and increasingly competitive industry. In another observation, it could possibly be that the RICS accredited curricula used to produce these graduates are not fit for purpose in responding to the needs and demands of a dynamic industry in the 21st century? Or, maybe, more external involvement in curriculum development through greater levels of collaboration between industry and the academic community, or more prescriptive guidance from the governing bodies could resolve the current competency requirements' impasse? Whatever the case might be, the perception gap has culminated in significant levels of frustration on all sides. In view of this, and to try and answer some of the above questions, the next section will review the process for appraising and benchmarking QS undergraduate courses in the UK with the aim of aligning and/or integrating the views of key stakeholders.

## 2.4 Programme appraisal and benchmarking

The validation and accreditation process in the UK requires HEIs to demonstrate how their academic programmes, especially on vocationally focussed subjects, have achieved the relevant competencies that support their degree awards. Programme appraisal and benchmarking, which involves validation and/or accreditation, is, therefore, a way of defining and determining the competency achievement of academic curricula. Programme validation is the process by which education providers align their curricula with internal standards and objectives or with national requirements, such as the QAA benchmarks in the UK, whilst accreditation is a review process to gain professional body endorsement by demonstrating that a certain course meets their academic standards.

The subject benchmark statement for 'land, construction, real estate and surveying' is a document produced by the Quality Assurance Agency for Higher Education (QAA) (QAA, 2019) in the UK and is written by subject specialists. Now in its fourth edition, the most recent revision was published in October 2019 to cover a range of subjects, *inter alia*, land surveying, planning and development, construction management, building surveying, QS and commercial management, property and real estate. The document provides a general guidance on the kind of study undertaken by, and academic standards that can be expected from, graduates in the stated areas of practice (QAA, 2019). In other words, they describe the knowledge, competencies/skills and understanding new graduates should possess upon completion of their degrees. Consequently, this document is used as a benchmark in the development, validation and periodic review of undergraduate (i.e. BSc (Hons)) QS programmes and for the articulation of associated learning outcomes. As pointed out by the QAA (2019), however, the benchmark is not to be used as a national curriculum nor is it meant to prescribe specific course design and delivery methods, thus allowing for creativity and adaptability in academic programmes. On the downside, it might well be contributing to the existing mismatches and perception gaps in graduate competency, as discussed previously (section **2.3**).

The benchmark standard in Figure 3 identifies a range of topics and knowledge components particular to the QS subject area. Albeit with no *expected* levels of attainment in competencies, graduates with a BSc (Hons) degree can achieve either a threshold standard (basic knowledge and understanding), a typical standard (knowledge application to a good level) or an excellent standard (high level understanding and application). QS graduates are also expected to develop the following seven generic skills and abilities in the course of their studies: communication; practical skills; digital literacy; intellectual skills; interpersonal skills and teamwork; analytical and data interpretation; self-management and professional development skills (QAA, 2019). The level of inclusion, and the extent of coverage, of topics and generic skills/competencies in course contents are based solely on the interpretation by the curriculum developer. Academic institutions are, therefore, encouraged to use this QAA statement in addition to any other applicable requirements to design, deliver and review programmes of study to ensure their continuing currency. Such requirements include employer and industry expectations as well as the demands of the professional, statutory and regulatory bodies (PSRBs) such as the Chartered Institute of Building (CIOB) and RICS.

| | **Threshold** |
|---|---|
| **6.6.5**<br><br>**Courses broadly concerned with construction:**<br><br>**Quantity surveying and commercial management** | Graduates have a basic understanding of the principles underpinning the management of finance, costs and value throughout the building and infrastructure life cycle from inception to demolition. In doing so they demonstrate regard for the physical, technological, legal, health and safety, economic, environmental, political and business decisions that affect cost and contractual advice.<br><br>Graduates will be able to:<br><br>i demonstrate an awareness of the mainstream technology and the resources it uses for constructing domestic, industrial and commercial buildings and infrastructure<br>ii describe the impact development has on the environment and initiatives to minimise energy, reduce carbon emissions, protect and increase biodiversity, flood protection and increase health and well-being<br>iii demonstrate an ability to measure and quantify to support the design process, production of project information and the commercial management of projects<br>iv demonstrate an appreciation of time, cost quality and value drivers affecting the design and construction and occupancy of buildings<br>v demonstrate an awareness of the legal and regulatory frameworks and systems impacting on the design and construction of buildings, and the principles of procurement and contract administration<br>vi demonstrate an awareness of digital technologies that support the construction process and the management of costs<br>vii recognise the roles of other professionals and parties associated with construction, property and surveying throughout a building's life cycle and be aware of the benefits of collaborative practice<br>viii recognise the importance of professional ethics, their impact on the operation of the profession and their influence on society, conflict avoidance/dispute resolution, communities and the stakeholders with whom they have contact<br>ix demonstrate an understanding of the principles and processes that deliver an inclusive environment recognising the diversity of user needs by putting people (of all ages and abilities) at the heart of the commercial management and quantity surveying process. |

*Figure 3: Benchmark standard - knowledge and understanding of graduates with a BSc (Hons) QS degree (QAA, 2019)*

The CIOB is one of the aforementioned PSRBs which accredit and set expectations for Bachelors' degrees with honours in QS and construction. The CIOB undergraduate education framework, which has been recently revised, is a wide-ranging document that sets out academic standards and requirements for construction courses in general (CIOB, 2018). The framework assesses learning in the following six major areas: ethics and professionalism; the construction environment; health, safety and welfare; construction technology; construction management, and sustainability. It is designed to be used for informing new, and reviewing existing, academic provisions in the built environment to maintain relevance, and for the purposes of gaining professional accreditation. As this is mainly a reference document, the framework provides guidance on learning outcomes rather than being a prescriptive syllabus.

Following the findings published in Publication 3 and the work of other proponents in the field (Nkado & Meyer, 2001; Perera & Pearson, 2011; Yogeshwaran *et al.*, 2018) on the lack of a defined graduate level of achievement in competencies, the CIOB, as well as the RICS, subsequently conducted a review of its accreditation policy and process and introduced some form of minimum threshold requirements for undergraduate studies. In the case of CIOB, this is reflected in the latest education framework for UG programmes (CIOB, 2018). Although this was considered a major change, the threshold learning outcomes under each key theme are broad and not consistently or clearly defined in terms of graduate competency levels. As a matter of fact, the threshold learning outcomes can be treated as expectations rather than absolute requirements that must be met (i.e. the skills and abilities that new graduates of such accredited degree programmes should possess). Of course, having (rather woolly) minimum threshold requirements is a step in the right direction and better than nothing. It helps academic providers achieve greater autonomy in programme design at best, but it does little to address the specific needs of the industry and employers' expectations as regards graduate competency achievements.

As the body primarily responsible for regulating the surveying profession, the RICS is, arguably, the most relevant PSRB which accredits Bachelor's with honours QS degree courses in the UK. It has the most influence on QS education globally. RICS accredited courses satisfy the educational requirements en route to a professional qualification and career in surveying. However, it remains contentious as to whether they fulfil the aspirations of the industry in terms of these courses producing competent QS graduates.

To gain accreditation, the mapping of a course to a certain RICS pathway such as QS is an important and a necessary criterion. The findings in Publications 1, 2 and 3 from the two RICS-funded research projects influenced the recently published RICS global policy in this regard. They provided the impetus for RICS to define, in a way, the competency levels for graduates of accredited institutions. Academic institutions seeking accreditation are now required to show how their course meets the Level 1 competencies in the chosen field (RICS, 2019). Whilst this is a welcome development (in addition to being a positive impact and a useful contribution by the body of work submitted), emphasis is still on the coverage of competencies rather than levels of attainment, which is the bone of contention, causing a gap in expectations.

It is worth pointing out that HEIs can still gain accreditation without meeting the defined competency requirements if they can provide adequate justification. Although Level 1 is the minimum threshold requirement set by the RICS, programmes can equally be designed to develop graduate competencies at Levels 2 and 3 which, therefore, explains the huge variability in the different RICS accredited courses as reported in Publication 1 and which is summarised in Figure 4 from supplementary Publication S1. As a vocational subject, however, employers expect new QS graduates to perform at Level 2 (and/or even Level 3) in several of the mandatory, core and optional competencies, as revealed in Publication 2; hence, the mismatch between the professional body requirements and the industry expectations of graduate competencies. With the education providers having to steer a, sometimes, difficult path, much of the time is spent moving 'from pillar to post' in an attempt to obtain equilibrium and produce highly employable and fulfilled graduates.

As shown in the supplementary report Publication S2, these concerns are shared by the participants of the CHOBE QS workshop IX which was held at Birmingham City University in 2012 and was attended by students, academics and industry experts. The consequent report analysed the delegates' views on how to educate quantity surveyors to meet future needs. But several inconsistencies were found in the views of the respondents with respect to: the role of professional bodies in setting course contents; the focus of HEIs (be it education rather than training); the extent to which degree programmes should allow for training, and even if QS programmes should include a compulsory placement module to this end.

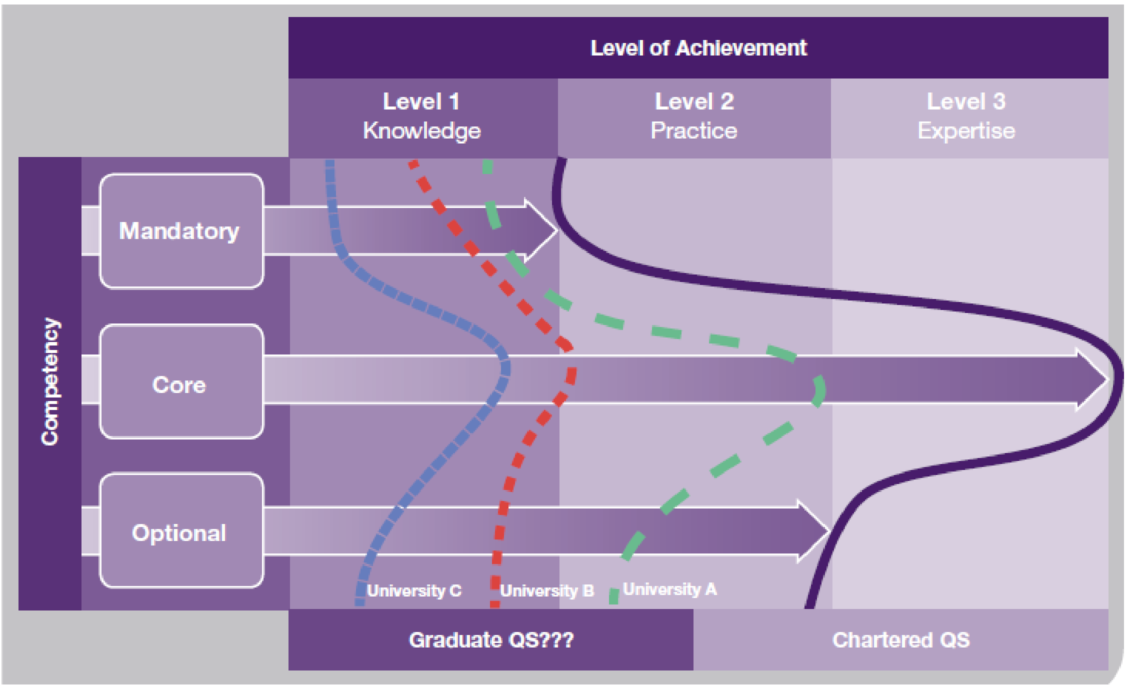



*Figure 4: Competency benchmark interpretation and the need for a defined graduate competency level (Publication S1)*

Clearly, prescriptive benchmarks and requirements from the PSRBs will not help in the quest for innovation and the need for a flexible and adaptive curriculum capable of responding to the needs of a dynamic industry and global trends. However, close alignment with the industry such as greater collaboration, specifically, between construction employers and professional bodies is required to negotiate and agree on undergraduate course curricula contents. This will help to manage industry and practitioner expectations of graduate competency levels. In other words, it can help to produce new graduates with the desired competencies and at the right levels.

To this end, a future emphasis should be on closing the professional body-industry-academia gap. To date, much effort and research has been directed towards industry and higher education integration, but what we learn from this body of work is that there is a growing need to bridge the gap between what the professional bodies require from an undergraduate curriculum and what the industry wants from its graduates. Paying more attention to this can, subsequently, help to close the industry-academia gap and to resolve the mismatch between the aspirations of the three key stakeholders, culminating in highly employable and fulfilled graduates. There must be a concerted effort at closing the academia-professional body-industry triangle with the missing link, which is the professional body-industry connection (see Figure 5). This is where Publication 3 made a significant contribution to knowledge, and it is where future studies and research can make further impact and break new grounds.

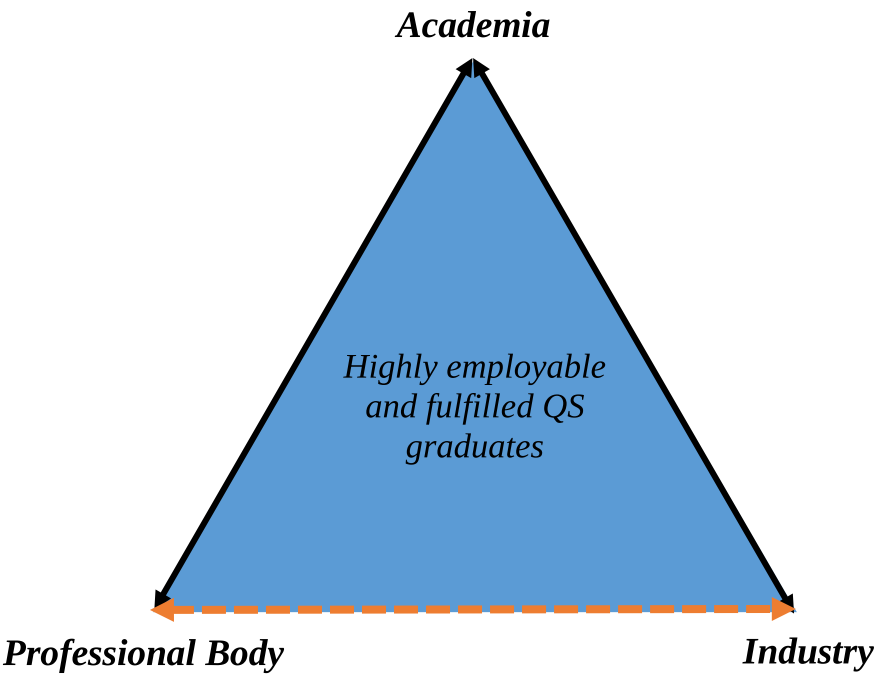



*Figure 5: Missing link in the integration (triple constraint) triangle*

Publication 3 seeks to align the views of the three key stakeholders through the development of a Graduate Competency Threshold Benchmark (GCTB). The GCTB, referred to as the final benchmark, defines graduate competency levels using the views of RICS', academic and industry experts. The perceptions and expectations of practitioners and educators regarding graduate level achievement and the importance of the ranking of RICS competencies helped to build the final benchmark. This final benchmark is a minimum threshold requirement for undergraduate QS studies in the UK that satisfies the aspirations of academic, industry and the professional body – the RICS' aspirations. A sample portion of the GCTB, which shows graduate competencies made up of the RICS APC study checklist and the total credit hours required to achieve each competency, is shown in Figure 6. As different courses interpret RICS' requirements differently (consequently, producing graduates with different levels of competencies who the industry sees as not meeting expectations), the results of Publication 3 also included a Competency Mapping Framework (CMF). The framework gives fresh perspectives on how construction courses map against competencies and provides a system for programme appraisal and evaluation. This framework has been used at Northumbria University to modernise its QS undergraduate provision and also for the periodic programme review of the QS programme to determine its academic health and ensure its continuing currency and industry-relevance. The positive impact the framework is having is reflected in the graduate employability score for this course and in the students' overall satisfaction with the course year-on-year.

| Graduate Competency Threshold Benchmark (GCTB) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Breadth Scale | | | | Depth Scale | |
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percent age |
| Code | RICS QS Study Check list Topics | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C1.8.7 | Supply chain management | 1 | 1 | | | | |
| C1.8.8 | Legislation on selecting project teams | 1 | 0 | | | | |
| C2 | CORE COMPETENCIES | 136 | 43 | 94.4% | 29.9% | 2060 | 65% |
| C2.1 | Commercial management of construction (T010) – Level 3 | 9 | 5 | 100.0% | 55.6% | 96 | 3.0% |
| C2.1.1 | Estimating | 1 | 1 | | | | |
| C2.1.2 | Establishing budgets | 1 | 1 | | | | |
| C2.1.3 | Cash flows | 1 | 1 | | | | |
| C2.1.4 | Reporting financial progress against budget | 1 | 1 | | | | |
| C2.1.5 | Procurement of labour | 1 | 0 | | | | |
| C2.1.6 | Procurement of plant and materials | 1 | 0 | | | | |
| C2.1.7 | Procurement of sub-contracts | 1 | 1 | | | | |
| C2.1.8 | Financial management of supply chain | 1 | 0 | | | | |
| C2.1.9 | Financial management of multiple projects | 1 | 0 | | | | |
| C2.2 | Contract practice (T017) – Level 3 | 28 | 12 | 100.0% | 42.9% | 243 | 7.6% |
| C2.2.1 | Principles of contract law | 1 | 0 | | | | |
| C2.2.2 | Legislation | 1 | 0 | | | | |
| C2.2.3 | Current case-law – look out for cases reported in journals | 1 | 0 | | | | |
| | Standard forms of main and sub contract – e.g. JCT, NEC/ECC, GC Works, ICE, ACA, | | | | | | |

*Figure 6: Sample portion of the final benchmark (Publication 3)*

## 2.5 Summary

There is sharp contrast between the more traditional forms of education, such as teaching for the sake of knowledge accumulation, and CBE which teaches students the ability to apply knowledge in practice. CBE has its root in developing technical skills and professional competencies (i.e. training for practice) in the chosen field. However, the desire to include cross-cutting skills continues to reinforce the need for the deep understanding and knowledge that higher education provides and/or offers. Undoubtedly, it is increasingly clear that a better connectivity of employers' wants with higher education offerings will result in the successful provision of CBE. It is on this basis, paired with a constructivist notion of CBE, that students should be given the chance to develop their competencies in a professional environment like that of their future workplace. Training is often the missing piece of the puzzle in academic pursuit, so "education" and "training" should not be "mutually exclusive" but rather complimentary, especially in vocationally focussed subjects such as QS.

One of the most important conclusions that can, therefore, be drawn from the above review is that training should be part of what a stellar education provides but it is not everything. Better still, marrying the positive aspects of both education and training should be considered a step in the right direction in curriculum design and development. The main conclusion here is that there is a need for improvement in the education and training of future quantity surveyors, expediently. QS-related sustainability and BIM education should be included in undergraduate courses in addition to achieving the right mix of academic knowledge, and experiential and cross-cutting skills. A construction sector-wide effort to boost the current and future competency attainment levels will not go amiss.

The principal conclusion of the publications submitted in this thesis is the assertion that there is dissatisfaction in the industry with the competency attainments of graduate quantity surveyors due to the absence of a defined threshold benchmark. Whilst there is now some clarity from the relevant PSRBs, the benefits are yet to be seen and/or recorded. The recent changes to the accreditation documents could be a timely intervention if appropriately applied and well received by both graduate employers and HEIs alike, but it is more important for major stakeholders (especially PSRBs and practitioners) to come together to mutually agree on the perceived and expected competency levels for graduate quantity surveyors. Future research may be needed on how to approach, and foster, this much needed collaboration and alignment of views.

The CMF, which includes the GCTB, developed in the body of work presented is a major step to this end and one of the key contributions to knowledge. The GCTB can help to connect QS graduate competencies better with industry needs and employers' expectations. The claim that the CMF can be used in autonomous programme design, appraisal and evaluation as well as for improving the outcomes of construction courses whilst allowing for flexibility to accommodate global trends and future needs remains a conclusion of this thesis. It is also an area by which the submitted body of work attempts to make a valuable contribution to knowledge.

# Chapter 3: Education for Sustainable Development

## 3.1 Introduction

A broad definition of sustainable development (SD) is given in the widely cited report by Brundtland and WCED (1987) which states that it is development that meets both the present and future generation needs in an uncompromising measure and an unselfish manner. According to Spence and Mulligan (1995), this is a tough ask based on the rapidly depleting natural (both biological and mineral) resources in addition to the alarming build-up of greenhouse gases causing climate change, infertile soil and famine, the loss of biodiversity and degradation, and also due to the threat to the global ecosystem and even human existence and security. It is on this premise that we must practically examine the different human activities responsible for the current unsustainable path of the global economy. The construction industry has been identified as a major contributor to environmental stress and strain (Sev, 2009; Celik, 2013).

To prevent the breaking point being reached and to avoid the impending prophecies of doom and the ugly scenes of disaster in all its forms, the construction industry as one of the largest global emitters and producers of pollutants at all levels must act. The activities of this industry and its supply chain (which shape our world and have a lasting effect on the natural habitat) use both renewable and non-renewable capital (i.e. natural and manmade) resources. The construction industry is, therefore, a major exploiter and heavy user of the world's scarce resources which include minerals and energy sources.

If we accept the above evidence, however controversial this may be, then there are significant implications for the built environment at large and for QS education which is the focus of this thesis. As such, the focus of this chapter is on: the importance, and likely challenges, of embedding sustainability in the built environment and of greening the academic curricula; the knowledge areas relevant to the QS profession in the light of its current and future role as informed by the sustainability agenda, and the extent of coverage of (including stakeholders' perspectives on) sustainability education within the BE undergraduate programme curricula.

## 3.2 Greening the BE curricula: importance and challenges

Used interchangeably and intimately connected, "education for sustainability" (EfS), "education for sustainable development" (EfSD), and "greening the curricula" are phrases that have been bandied around in recent times (Cotgrave & Alkhaddar, 2006; Forrant & Silka, 2006; Paraschivescu & Botez, 2011; Altomonte, Rutherford & Wilson, 2014; Thakran, 2015). As Publication 6 recently pointed out, although the period between 2005 and 2014 was the United Nations Decade of EfSD, there is still a growing need for sustainability literacy in the BE, and curriculum greening must proceed as quickly as possible. The importance and benefits of intensifying education on sustainability concepts (especially in developing knowledge areas relevant to construction professionals to improve their understanding of SD and how to achieve this in the built environment) are well documented in the literature (Spence & Mulligan, 1995; Paraschivescu & Botez, 2011).

The construction sector has a major role to play in achieving the sustainable development agenda which, therefore, reinforces the need for developing the sustainability skills, knowledge and understanding of BE professionals. Greening the curricula of their formal education is vital to this end. In fact, the findings from Cotgrave and Alkhaddar (2006) show, unequivocally, that UG construction programmes need to produce graduates with a high level of sustainability literacy. In a nut shell, EfSD or EfS is a process of learning that involves taking a long-term positive view of the ecosystem, social welfare and economic prosperity of the earth (Paraschivescu & Botez, 2011; Thakran, 2015). Curriculum greening is a means to an end, a way to embed or integrate SD concepts and principles into education.

Indeed, education is vital in changing attitudes which, in turn, help to shape human behaviour. As reported in Cotgrave and Alkhaddar (2006) and reiterated in Thakran (2015), the importance of education on sustainability is rooted in the need to change attitudes and halt the prevalent irresponsible behaviour that is the leading cause of most of the environmental problems we have today. This notion clearly aligns with the preliminary context provided in the Brundtland Report (Brundtland & WCED, 1987) that maintained that mankind can make development sustainable only if we are determined to do so. In other words, sustainable development is achievable with the right behaviour which reflects our viewpoint as influenced by EfS. Publication 6 considers this as a battle that will be won not in the field, but through education in the classrooms of academic institutions. This is necessary if any concomitant government initiatives and policies are to have any real impact and direct bearing on unsustainable practices, attitudes and behaviours.

Greening the curricula is thus a philosophical term that has been coined to achieve EfS and to ensure that academic programmes are churning out graduates, future practitioners and policymakers with the capability to preserve ecology. This involves education and training on sustainability concepts and practices to create awareness and to develop the necessary skills and competencies in new graduates (Forrant & Silka, 2006). The approaches to EfS, as Thakran (2015) puts it, must take into account the world's well-being from a local vantage point and should demonstrate how indigenous cultures and disciplines can contribute, in their own way, to the common cause and greater good. In the case of construction, sustainability-literate professionals can create a more sustainable built environment i.e. buildings and facilities with reduced environmental impact that do not cost the earth nor exhaust the world's limited resources; a built environment that complements and rejuvenates, rather than damages or diminishes, the natural environment.

Despite the above and the promise of EfSD, there are several barriers preventing the appropriate inclusion of environmental contents in programme curricula (Forrant & Silka, 2006; Altomonte *et al.*, 2014). The common barriers to the inclusion of sustainability within professionally accredited construction related courses in the UK, as revealed by Cotgrave and Alkhaddar (2006), are:

- the structure and funding of academic institutions do not incentivise change and sustainable practices;
- academic resistance to changes in the curriculum especially beyond their core area of expertise;
- lack of time and interest from academic staff;
- inadequate guidance from subject benchmarks and professional body requirements;
- student attitudes, and
- the perceived importance of SD by practitioners.

Although, McFarlane and Ogazon (2011) and Abu-Hola and Tareef (2009) see the lack of an agreed definition for SD in the literature as a principal challenge to curriculum greening because it leads to different interpretations and fragmented practices, the other barriers discovered by these authors reinforce the findings from previous research.

There is some resonance here with the findings of Publication 6 which identified some further challenges to a sustainability-literate construction curriculum as:

- the teaching, learning and assessment approach;
- time constrictions;
- the supposed lack of expertise on the part of construction practitioners and educators including quantity surveyors;
- the lack of a cogent strategy at university level (and from the industry);
- fragmentation and the gap between industry and academia;
- the funding structure and organisation of UK universities;
- staff attitudes, and indifferent behaviour.

So, whilst we can be united in advocating for the diffusion of sustainability principles and concepts into QS degree programmes and, more generally, into the BE curricula because of the accruing benefits, its enactment within the education process is not straightforward. Although some progress has been made in addressing some of these barriers such as, *inter alia*, defining the knowledge areas relevant to the QS profession as well as sustainability mapping to the construction curriculum using stakeholders' views, as explored in the later sections, more still needs to be done.

## 3.3 Knowledge areas relevant to the QS Profession

This section explores the sustainability knowledge areas and the key themes that should be embedded into a QS undergraduate curriculum, namely a programme designed with the aim of producing sustainability-literate graduates who are competent and capable of meeting current employer expectations and future industry needs. If we are to accept the findings of both the study carried out by Shayan *et al.* (2019) and the review conducted above, a most critical challenge for future QS graduates is to intensify their holistic sustainability knowledge in relation to construction. As pointed out earlier in the previous chapter, the ability to advise on sustainability is now perceived to be in the top two of the required demands and vital in the emerging role of QS graduates in the 21st century; the second one being the ability to use BIM for current QS practice, as explored in the next chapter.

The sustainability-related contents in programme curricula, and the levels at which they are taught, differ considerably from one university to another (Bhattacharjee, Ghosh, Jones & Rusk, 2012). It was reported in Forrant and Silka (2006) and in Xia, Rosly, Wu, Bridge and Pienaar (2016) that no two academic institutions provide the same sustainability education, on the one hand, due to the intricacy involved and the lack of specific guidance. On the other hand, the research culture of universities' academic staff was perceived as the reason for the variance in the sustainability-related contents in architecture education (Edwards, 2004).

Also, compared with other BE programmes (such as building surveying, construction management and the like) it was discovered that QS students have a lower level of the understanding of sustainability concepts despite their crucial role in delivering SD (Xia *et al.*, 2016). In some cases, studies that examined the sustainability contents of BE courses focused on the traditional disciplinary compartments within economic, social and/or environmental aspects. Indeed, there are different interpretations of sustainability concepts with no clear agreement as to what sustainability knowledge in construction programmes should entail (Bhattacharjee *et al.*, 2012). This is exacerbated by the mixed messages coming from the industry and professional bodies alike (Blewitt & Cullingford, 2004; Forrant & Silka, 2006).

Whilst there is now a multitude of research in EfSD in the built environment, there is limited study, with the exception of Xia *et al.* (2016), on investigating sustainable construction knowledge attributes and requirements for undergraduate QS courses. Even, the aforementioned study only investigated the sustainability attributes of a single undergraduate QS course in Australia. It was never the intention in that study to explore the sustainability contents and topics that should form an integral part of every future-oriented QS curriculum. The guides and standards from PSRBs are not much use either in terms of the specifics to be covered. Previous studies have typically suggested, from the data analysed, that sustainability-related contents' coverage in professionally accredited QS courses is actually very low (Perera & Pearson, 2011; Xia *et al.*, 2016).

More worrying, studies that define specific knowledge areas using high level (key themes) and low level (topics/contents list) classifications for the purpose of benchmarking and setting sustainability learning outcomes/objectives in QS curricula are difficult to come by, if not rare. For example, Bhattacharjee *et al.* (2012) only provided a bird's eye view of the sustainability contents in construction programmes offered by the Associated Schools of Construction (ASC) member universities in the United States. Earlier, Cotgrave and Alkhaddar (2006) conducted a similar study but for the CIOB accredited construction management programmes in the UK. Cotgrave and Alkhaddar came to a similar conclusion that the broad approach to curriculum greening means there is no discipline-specific model that could serve as best practice for educating the current and future environmentally-literate professionals that the industry requires. In an explorative study of construction management programmes in the UK and Australia, Cotgrave and Kokkarinen (2010) could only develop an abstract model which shows recommended reflective activities in sustainable construction curriculum design. The process-orientated model is just a set of principles to help with sustainability considerations when designing a construction curriculum; it is not proposed as a sustainability framework which identifies knowledge areas relevant to construction.

This is where Publication 4 contributes to the existing literature, through the development of a QS-specific sustainability framework as shown in Figure 7. An exploratory case study approach was used to develop the framework which included a number of RICS accredited QS courses in the UK and contacting key academics from these institutions, selected based on geographical location. Although, the development process for the framework was delimitated by some constraints, the identified knowledge requirements can be used to map the sustainability contents in a QS curriculum. Additionally, the framework can be used to develop new programmes capable of producing the sustainability-literate quantity surveyors of the future, and also for the sustainability alignment and the benchmarking of existing programmes. The framework was influenced by the sustainability agenda, the future challenges for the QS profession, and global trends. So therefore, its application in curriculum development should produce responsible graduates that meet current industry expectations and the emerging role for professional quantity surveyors in the new world of work focussed on achieving SD.

What the framework does not explain, however, is the level of proficiency required in each of the identified themes and topics. Future research should incorporate industry views on the framework and align academic perceptions with that of the industry regarding graduate level attainments. Suffice it to say that sustainability is a global phenomenon that requires international and local measures. Further study, in keeping with the global trends (particularly with regard to the policies and regulations endorsed to promote SD) will be required to extend the application of the framework in QS curricula outside the scope of study or post any Brexit effects in the UK. Nevertheless, the developed sustainability framework can, at least, serve as a springboard in any future studies or academic-industry negotiations aimed at reaching a consensus on QS curriculum greening. It can also be used in curriculum development/revision for sustainability mapping in QS undergraduate education. Further studies will overcome the limitations of the body of work presented and should trigger conversations about the general applicability of the framework.

| SUSTAINABILITY FRAMEWORK | | | | | | |
|---|---|---|---|---|---|---|
| HIGH LEVEL CATEGORIES | **CATEGORY A – BACKGROUND KNOWLEDGE AND CONCEPT** | **CATEGORY B – POLICIES AND REGULATIONS** | **CATEGORY C – ENVIRONMENTAL ISSUES** | **CATEGORY D – SOCIAL ISSUES** | **CATEGORY E – ECONOMIC ISSUES** | **CATEGORY F – TECHNOLOGY AND INNOVATION** |
| LOW LEVEL CATEGORIES | Sustainable development overview and principles<br>Climate change and global warming issues<br>Impact of the construction industry on the environment<br>Sustainable construction concept<br>Role of QS in sustainable development | Changes to Building regulation, e.g. Part L (energy efficiency) and Part F (means of ventilation)<br>Code for Sustainable Homes<br>Energy Performance Certificate (EPC)<br>The Kyoto protocol<br>Relevant EU Directives such as the EU climate policy, EU ETS, etc.<br>Climate Change Act<br>Sustainable Construction Strategy<br>Sustainable Procurement Action Plan | Protecting and enhancing the built and natural environments<br>Environmental Impact Assessments (EIA)<br>Environmental Management Systems: ISO 14001<br>Environmental Assessment Methods: BREEAM, LEED, Green Star<br>Reducing energy consumption, that is, emitted and embodied<br>Reducing greenhouse emission such as methane, carbon, nitrous oxide and refrigerant gases<br>Carbon Agenda (Carbon footprinting, Zero Carbon, Retrofit)<br>Waste reduction principles (recycling, reduction, reuse, effective design)<br>Brownfield development<br>Natural resources, renewable and non-renewable materials<br>Water usage and Sustainable Transportation Plan | Corporate Social Responsibility (CSR)<br>Ethical issues such as ethical sourcing of materials and labour, for instance<br>Equity and social justice<br>Community development and social inclusion<br>Health and safety<br>Employment, training and education<br>Social assessment methods (e.g. Design Quality Indicators, KPIs and benchmarking, etc.)<br>Cost Benefit Analysis (i.e. impact of human factors on the community) | Cost planning and management<br>Value management or engineering (cost of alternative materials and designs)<br>Sustainable procurement strategies<br>Feasibility studies<br>Whole-life appraisal/Life cycle costing<br>Financial incentives (such as subsidies, climate change level, aggregate tax, carbon credit, Brownfield land tax, etc.) | Renewable energy technologies (Photovoltaic, Wind Turbine, Geothermal, Biomass, etc.)<br>Green Building Materials<br>Rain water harvesting and Grey water collection systems<br>Professional and management software packages such as BIM, etc.<br>Modern methods of construction: offsite production, use of precast material, lean construction, etc.<br>Passive design methods such as day lighting, intelligent facades, carbon storage and offsetting, etc.<br>Supply chain management<br>Effective information control and management (using e-business) |

*Figure 7: Sustainability knowledge areas relevant to future QS professionals (Publication 4)*

## 3.4 Sustainability mapping within the curriculum: stakeholder perspectives

This section examines academic and industry views with respect to the extent of the coverage of sustainability education in undergraduate degree programmes in order to understand the real picture. As the management thinker, Peter Drucker, once said, "*If you can't measure it, you can't improve it*" (Drucker, 2002). The findings of the publications submitted are also explored in this regard. Despite the increasing global awareness and perceived importance of EfSD, a comprehensive survey of various construction stakeholders and BE practitioners shows that existing degree programmes are mostly inadequate and that there is much scope for improving their sustainability contents (Altomonte *et al.*, 2014). As revealed in this European Commission funded project carried out by Altomonte *et al*. and conducted in some 40 different countries worldwide and involving BE accreditation bodies, the practitioners questioned believe that there is a sustainability skill gap with regard to both new graduates just entering the markets and seasoned professionals, and these practitioners think curriculum greening is the solution to the problem.

Other studies (Forrant & Silka, 2006; Bhattacharjee *et al.*, 2012) that examined the views of academic stakeholders on sustainability mapping within AEC education agree broadly with this view from industry. For example, a recent study conducted by Trad (2019) shows a low level of sustainability integration (about 7.7%) within undergraduate programme curricula at an Australian university. The stated percentage is the average score of sustainability integration across its suites of construction-related programmes. Altomonte *et al.* (2014), Bhattacharjee *et al.* (2012), McFarlane and Ogazon (2011), Abu-Hola and Tareef (2009), and Forrant and Silka (2006) also reported unsatisfactory levels of coverage and/or a misalignment of sustainability contents in the AEC programmes they examined. Even though the analyses of the data in these studies suggest that there is inadequate coverage of sustainability in most programme curricula, it is not clear from these studies what the acceptable level should be, and a reasonable conclusion cannot be reached because there is no basis for comparison.

To help fill this gap, Publication 4 investigated the coverage of sustainability in RICS accredited QS degree programmes in four UK universities using the framework developed earlier. The results show notable differences in the extent of sustainability education among the four case studies, with more prominent variations observed at the category level. Drilling down into the results, the programmes that fared better in certain knowledge areas had more research active staff/better organisational structure. This confirms previous research presented in section 3.2 above that there is some synergy between university culture/staff expertise and curriculum greening. For example, a research-intensive university will develop more research active staff who have up-to-date knowledge and thus feel more confident to teach contemporary topics in, say, technology and innovation. If we link this back to the education versus training debate in chapter two, the essence of universities as a strenuous protagonist of deep academic inquiry is brought to the fore. Still, this does not undermine the value of experiential training in the goal of achieving CBE. A typical example would be the industry expectation for new QS graduates to be proficient in the use of BIM for cost management, as highlighted in chapter two and discussed in the penultimate chapter.

The construction sector is a major driver of the economy but can also be a main antagonist of the ecosystem by being a major polluter and a heavy user of the world's natural and manmade resources. As an integral part of the construction sector, professional quantity surveyors have a key role to play in achieving SD and in delivering a sustainable future. It is also important to know the extent of sustainability coverage in undergraduate education from the perspective of QS students who are the future workforce and future major industry stakeholders. As previously pointed out, one of the main barriers to achieving sustainable construction and a sustainable future is irresponsible behaviour influenced by negative attitudes (towards SD) which can be corrected through EfS. It is against this backdrop that exploring student perception on their level of knowledge and on the perceived importance of sustainability concepts and issues becomes critical. This is important to see how well the curriculum is performing in training sustainability-minded and literate future professionals.

A study by Boca and Saraçlı (2019) examined the perception, attitude and environmental behaviour of engineering and management students at a university in a south eastern European country, and found a positive relationship between these three variables. Another study carried out by Cotgrave and Kokkarinen (2011) tested a previously developed theoretical model at a UK university to see if it improved students' sustainability knowledge, skills and attitudes. They concluded that the process-orientated model, a set of recommended reflective activities, produced a positive and significant change in students' attitudes towards SD. Additionally, both an attitudinal survey from an Australasian study led by Holdsworth and Sandri (2014) and an opinion survey from a multi-national study fronted by Boarin, Martinez-Molina and Juan-Ferruses (2020) yielded similar results.

The focus of Publication 5 is to identify knowledge gaps by establishing students' knowledge levels and comparing them with the perceived importance of the sustainability categories in the framework developed in Publication 4. An analysis of the results shows that students place a high importance on sustainability education even though their knowledge levels were found to be low across all categories. This was most noticeable in the policies and regulations' category where the gap was large. If our students, the so-called future professionals, feel this way then it is understandable as to why the current practitioners in the industry survey referred to above believe there is a sustainability skill gap and the need for more education in this area.

Of course, education can influence the attitudes of the future workforce which, in turn, might help to change behaviour over time. As 'learning' is a better barometer of understanding rather than 'what is being taught', identifying students' knowledge gaps and where they lack confidence can help to better green the curriculum. But the real litmus test must be whether sustainability education can change attitude from 'knowing' to 'wanting to care and do something about preserving ecology'.

In concluding this chapter, it should be noted that Publications 4, 5 and 6 argue strongly for the alignment of QS education with the sustainability needs of the industry to help satisfy employers' requirements and they have provided the impetus for updating QS undergraduate courses at various UK universities; for example, the integration of embodied carbon counting aspects in the quantification and costing module at both Northumbria University and the University of Salford. Additionally, Publication 4 has produced a framework that can be used for educating sustainability-literate QS professionals who can, upon graduation, contribute to the effective delivery of SD in the construction sector and society at large.

## 3.5 Summary

Changing the attitudes of new graduates, who are the future custodians of the global ecosystem, through education on sustainability is crucial. Sustainability-literate BE professionals (such as quantity surveyors) can contribute a great deal to achieving SD in the construction sector and beyond. The principal contribution of the publications submitted in this thesis is that they reveal that there is no formal mapping process or a set threshold standard for integrating a reasonable level of education on sustainability into undergraduate construction curricula. In addition, a lack of a common definition/common agreement on what SD should entail is causing different interpretations by HEIs and is hindering the development of structured QS curricula.

The identified knowledge areas relevant to the QS profession identified in the publications, which is one of the key contributions to knowledge, provide a set of well-structured concepts that can be used for modelling sustainable curricula. They can form an integral part of every future-oriented QS course. However, further research is required to sample industry's perceptions on the high- and low-level themes in the "framework". This is necessary to ascertain both the industry requirements and the employers' expectations from new graduates through the ranking of importance of the identified sustainability themes in the framework.

Reflecting on the common issues in Publications 4, 5 and 6, a sustainability threshold benchmark like the GCTB in chapter 2 is suggested for the further integration of sustainability literacy into BE education and to redress the skill gap in practice. A minimum standard which aligns professional, academic and industry views and allows for innovation can produce competent graduates with the required level of knowledge and skills in sustainability. This assertion remains a conclusion of this thesis.

# Chapter 4: BIM and Multi-disciplinary Education

## 4.1 Introduction

The benefits of BIM are widely recognised and well documented in the literature but its uptake in the multi-disciplinary construction industry is not as prominent as it could be. BIM is an acronym for building information modelling, sometimes referred to as building information management in some quarters. It can be argued that the core concept of "BIM" is synergetic to "sustainability", which is discussed in the previous chapter. In other words, the implementation of BIM on a project can help to achieve sustainable development and construction through *inter alia* whole life cycle thinking, carbon reduction, waste minimization and process innovation (Zainon, Mohd-Rahim & Salleh, 2016; Georgiadou, 2019).

Whilst the uptake and implementation of BIM in the construction industry is currently emerging and slow to take off, the ability to use BIM has become central to the QS profession and, together with the synergetic sustainability knowledge, has been dubbed as the most important skill for the future quantity surveyors working in a multi-disciplinary environment (Wu, Wood, Ginige & Jong, 2014; Shayan *et al.*, 2019); a thought shared by the industry and professional bodies alike. RICS, which regulates the profession, now has BIM themes running through its entire list of mandatory, core and optional competencies in the latest QS pathway guide (RICS, 2018a, 2018b).

Against this backdrop, the findings from the literature and from the publications submitted in this thesis on the interrelation between BIM theory and practice will be presented and discussed. In particular, three main issues are explored:

- the potential of BIM in the global AEC sector as well as its drivers of, and benefits for, the QS profession (section 4.2);
- the barriers to BIM incorporation into the AEC academic curricula, especially QS undergraduate programmes (section 4.3), and
- the multi-disciplinary nature of BIM and the need for a collaborative multi-disciplinary (BIM) education (section 4.4).

The multi-disciplinary education domain is a huge one and the body of work presented in this thesis covers only part of the ground.  It would be misleading or, at best, tempting to assume that section 4.4 provides an exhaustive body of work in this regard. Whilst multi-disciplinary education is never the focus in this chapter, its inclusion in section 4.4 does add to the understanding of BIM implementation (section 4.2), and of educational challenges (section 4.3) and collaborative learning, particularly in the QS context which is the focus of this thesis. The collaborative nature of BIM and how its full adoption can help to achieve integrated project delivery in construction through multi-disciplinary learning is briefly explored. In other words, BIM implementation in practice and its integration into AEC undergraduate curricula can encourage and help to rekindle the much-needed collaborative multi-disciplinary approach (Macdonald & Granroth, 2013; Zhao, Sands, Wang & Ye, 2013; Puolitaival & Kestle, 2018).

## 4.2 BIM implementation: drivers, benefits and barriers

BIM is often described either as a technology (software products) or a methodology (process innovation) or, by most scholars, as a combination of the two. Irrespective of the perceived schools of thought, there is a general consensus that BIM is an appraisal framework used in a project’s life cycle for visual representation and digital information management. The BIM process supports the creation, management and sharing of facility life cycle data using visualisation model tools in a collaborative setting.

Özorhon and Karaciğan (2020) pronounced, based on the results from an industry survey and a real-life case study, that project level factors account for up to 80% of BIM drivers. An earlier study by Wong, Salleh and Rahim (2015) affirms this also; that BIM implementation by a firm is mainly driven by the need to improve project performance and outcomes. This includes the need for improved collaboration and coordination; improving project performance (time, cost, quality, efficiency and risk reduction); design improvement (visualisation and clash detection), improving construction productivity, and reducing life cycle costing. Interestingly, government influence (industry level factors) as well as the need for firms to gain competitive advantage and maintain a good company image (firm level factors) only account for the remaining 20%.

This is in contrast with the findings from the literature that suggest government push and requirements are the main drivers of BIM (Ghaffarianhoseini *et al.*, 2017; Vass & Gustavsson, 2017; Georgiadou, 2019). Although the above conflicting narratives may seem perplexing, evidence suggests that the level of experience of the sample audience will influence a study finding. For example, further probing of the studies reveals that practitioners working for a large organisation or on major infrastructure projects see the need to improve project outcomes as their main drivers of BIM. On the flip side, those working for small and medium sized enterprises (SMEs) are reluctant to implement BIM and perceive government influence and perhaps the need for a good public image as the main driving force. The opinions also vary within public and private sector projects.

Nevertheless, the benefits of implementing BIM in practice on a project are quite enormous. Some of the recorded benefits include lean construction and integrated project delivery, quality assurance and on-time delivery, life cycle thinking and sustainability (Georgiadou, 2019). Other reported benefits from projects that have utilised BIM include clash detection, substantial time savings, process innovation, waste minimisation, cost efficiency and whole life cycle cost reduction (Bryde, Broquetas & Volm, 2013). These benefits, afforded to all AEC professionals, were grouped by Ghaffarianhoseini *et al.* (2017) into technical, knowledge management, standardisation, diversity, economic, integration, planning/scheduling, building life cycle analysis and decision support benefits. It should be noted that BIM can be achieved or implemented to different levels of competence, otherwise referred to as BIM Maturity, ranging from Levels 0 to 3 as defined by the UK BIM Task Group (Underwood & Ayoade, 2015). The target set by the UK government was Level 2 BIM on all centrally procured projects by 2016, which is fully collaborative 3D BIM (Cabinet Office, 2011).

In particular, BIM presents unique challenges as well as huge opportunities for the QS profession as declared by Wu *et al.* (2014). Starting with opportunities, BIM can be used for, *inter alia*, quantification and costing, and the possibilities here are endless in terms of whole life cycle costing and embodied carbon counting just to mention a few. Whilst relevant BIM technology is key to performing the aforementioned emerging/future QS role, it can equally support/enhance current QS practices through, for example, automated quantity take-off and billing from digital models, (Stanley & Thurnell, 2014; Wu *et al.*, 2014; Ismail, Drogemuller, Beazley & Owen, 2016; Zainon *et al.*, 2016).

It is apparent that some companies/practitioners now routinely deploy BIM capabilities on their projects to improve outcomes, albeit at different maturity levels. BIM usage globally can be attributed to governmental interventions and requirements for efficiency in the AEC industry. This is the case, at least, in the UK, US and many other European/developed countries around the world (Wu *et al.*, 2014; Ghaffarianhoseini *et al.*, 2017; Vass & Gustavsson, 2017). In terms of taking the lead, BIM is now often used on major infrastructure and government projects, although its adoption in the private sector and for small projects is still widely restricted. Additionally, despite the growing awareness of, and the importance of, BIM in the construction industry worldwide, many developing countries are still lagging behind in the adoption and implementation of BIM.

Georgiadou (2019) uncovered from a study conducted with construction professionals in the UK that life cycle/long time benefits are often ignored on a project primarily due to short term thinking, industry fragmentation and skill shortage. According to Georgiadou, the challenges concerning BIM implementation in the AEC industry can be broadly classified into: financial barriers especially for SMEs (to buy software packages and train staff); technological barriers (in terms of performance, interoperability and reliability); cyber security and legal barriers (regarding confidentiality, integrity and protection of electronic data); low client demand apart from that generally driven by the government, and cultural barriers such as resistance to change and the reluctance to move from traditional procurement to an integrated approach. BIM implementation requires significant investments in hardware, software and staff training/upskilling to exploit the full potentials and the benefits it can offer. Hence, cost is the most frequently reported barrier in the literature, especially for SMEs. In addition, a lack of experience and proper engagement is often cited as the leading cause of the low return on investment still typical of BIM usage. This is why Bryde *et al.* (2013) professed that BIM education and training is key to redressing this issue for future professionals.

Similarly, Wu *et al.* (2014) asserted that BIM is not systematically filtering through the QS profession in the UK largely due to the incompatibility of the mainstream QS-related software with UK measurement rules and building classification systems. As pointed out by Ismail *et al.* (2016) BIM usage among BE professionals is lagging far behind the usage by architects. In fact, it is reported that some quantity surveyors in the UK and abroad are still not aware of BIM and that only a small percentage have used BIM (Wong *et al.*, 2015; Ismail *et al.*, 2016). Despite BIM for cost management being identified as critical in a future QS role, QS firms are yet to figure out how best to make use of BIM in their practices. The main obstacles identified as being responsible for this slow adoption rate/pace relates to poor quality models and insufficient information; data exchange issues; varying standards and unsuitable billing formats (Wu *et al.*, 2014). Stanley and Thurnell (2014) concurred with the above findings and added that the more general challenges of BIM implementation in the AEC industry equally applies to the QS profession.

To overcome the challenges of BIM uptake and implementation in practice, a concerted effort is required if progress is to be made. Whilst the above captures the rhetoric and reality of BIM practice mostly from industry perspectives, the views of other stakeholders are also vitally important. As there are limited studies which examine the drivers and benefits of BIM implementation in QS practice from academic and students' perspectives, especially in a developing country context, Publication 7 makes a useful contribution to knowledge in this regard. Academics were specifically targeted for this study because of their role in preparing students for practice, and final year QS students were also sampled because of their appreciation of programme learning outcomes and being the industry's future practitioners. This approach is not uncommon especially when trying to build a general consensus and trying to align the views of key players on global issues that affect theory and practice such as EfS and BIM.

The most important driver, as identified from Publication 7, is the firm level factor such as the need for innovation in order to gain competitive advantage. The project level factor (such as developing the ability to provide whole life value to the client) came a close second, and the availability of trained staff from industry and academia also featured in the top five drivers. Out of the 12 identified BIM drivers, the industry level factor (such as client demand for BIM usage on their projects) ranked least. The findings here make interesting reading. Whilst some in the industry see the need to improve project outcomes as the most important driver, which is commendable, academics perceive innovation by firms to gain competitive advantage as the key motivating factor of BIM usage in the industry. Although it is not the intention here to adjudicate, the academics being the neutral party here might just be stating what they already know about companies' motivation, in general. If improving project outcomes was the order of the day in the construction industry, perhaps the adversarial culture would not be so rampant – just some food for thought!

Moving on, it is reassuring to know that both academia and industry views can align sometimes, for instance, with respect to low clients' demand for BIM usage. Whilst governments in developed nations, such as the UK, are taking action through policies and legislation to improve this, developing countries, like Nigeria, can only engage in wishful thinking for now. The desire to provide whole life value to clients using Level 3 BIM reinforces why BIM for cost management is considered as an emerging QS role. Equally important is a skilled workforce to implement BIM in practice and competent academics to train future professionals. These are areas where, as both academics and practitioners agree, the current QS undergraduate education is lacking.

Regarding the benefits of BIM implementation, Publication 7 confirms the results from previous studies (Bryde *et al.*, 2013; Stanley & Thurnell, 2014; Ghaffarianhoseini *et al.*, 2017) but with an added caveat that BIM for cost management should be compulsory for future QSs to remain relevant in the 21st century and to help deliver the sustainability agenda in the AEC industry. The publication provides fresh insights into the fact that BIM knowledge is critical to QS practices, be it in developing or developed countries, in order to meet the future needs of the global construction industry in a sustainable manner.

## 4.3 Challenges of integrating BIM into undergraduate curricula

BE programmes, both in developed and developing countries, strive to incorporate BIM into their academic curricula. The motivations for this are well documented in the previous section which explores the drivers, benefits and challenges of BIM adoption and implementation in practice. Companies benefit from BIM usage, as do AEC practitioners and, more widely, the global industry (Shelbourn, Macdonald, McCuen & Lee, 2017). It has, indeed, never been so important to have a BIM trained workforce. This is especially important because several of the challenges to BIM implementation in the AEC sector (identified in the previous section) relate to lack of competence. Hence, the role of academic institutions in educating future professionals who meet industry demands cannot be overplayed (Chegu Badrinath, Chang & Hsieh, 2016). This section, therefore, explores the challenges of integrating BIM into universities' AEC curricula.

The report of the BIM Academic Forum (BAF) (Underwood & Ayoade, 2015) provides some insights on this. BAF consists of academic members from several HEIs in the UK, that have AEC provision, who have the shared objective of promoting BIM education, training, learning and research in the built environment. The report, which was supported by Advance HE (previously HEA) and the UK BIM Task Group, examines the existing position and challenges of BIM education in UK HE. The likely challenges of embedding BIM in BE education were grouped into four key areas related to staff upskilling, industry engagement, learning framework, and keeping abreast of BIM developments (Underwood & Ayoade, 2015). A BIM learning outcome framework was subsequently developed for use in undergraduate and postgraduate BE curricula including QS degree programmes. In a later study, Shelbourn, Macdonald and Mills (2016) also developed an illustration, manipulation, application and collaboration (IMAC) framework to help negate some of the issues impacting upon the learning and teaching of BIM to AEC students in the HE sector.

Puolitaival and Forsythe (2016) investigated the challenges of HE in New Zealand in producing BIM-ready construction graduates. The practical challenges faced in the development and implementation of a BIM-focussed construction curriculum were identified through an action research study. The main barriers discovered included: the availability of suitable BIM learning and teaching resources; enhancing the professional development of staff; mitigating between BIM theory and praxis; finding the sweet spot between conventional practice and emerging methods, and between process and technology. Finding suitable BIM models was reported as being particularly challenging which was why the authors recommended further research in this area. An earlier but similar study in the US which used academic and student views to reach its conclusions broadly agreed with the above challenges of integrating BIM into construction-related programmes (Woo, 2007).

Kocaturk and Kiviniemi (2013) focussed on the challenges of embedding BIM into UK architectural education but found anxieties and resistance rooted in such issues as how it would affect accreditation, and how staff could adapt to the required knowledge and skills in the ever dynamic and rapidly evolving BIM environment. Also, it can be deduced from the findings and the questions posed in the study that the perceived superiority and autonomy of the architect is under threat with the collaborative approach of BIM. This was seen as a major anxiety and one of the root causes of resistance to BIM integration in architectural education. If anything, what we can learn from this likely tension is the human factor/element at play which, without doubt, is an underestimated barrier.

Chegu Badrinath *et al.* (2016) usefully and succinctly classified the barriers of integrating BIM into AEC curricula using the trio of policy, processes and technology. The policy difficulties that could be faced include professional accreditation problems; inconsistent global accreditation; variable BIM skill requirements; BIM learning outcome issues, and lack of motivation. Technology issues relate to obtaining relevant object libraries; software licences; appropriate tools, and IT facilities. Process barriers include the need for collaboration and multi-disciplinary learning; inadequate BIM curricula, and the gap between academia and industry. Evidence suggests that policy issues are externalities and motivation will increase with favourable BIM polices. Similarly, technology barriers are usually beyond the area of influence of a curriculum developer because these are cost related. But process issues can, and should, be addressed through curriculum design. Whilst the need for industry and HE integration has been reasonably explored in chapter 2, the concept of multi-disciplinary/team learning as germane to BIM education will be explicated in the next section to help redress the inadequate BIM curricula.

The previously discussed research and studies have focussed on the challenges of integrating BIM into undergraduate AEC curricula mainly in the UK and other developed countries. As the emphasis is on the global QS profession, practised mostly in the UK and several Commonwealth countries, it is, therefore, important to understand the barriers for BIM incorporation into undergraduate curricula in both of these contexts. To this effect, Publication 8 examines the challenges of integrating BIM into QS degree programmes in a Nigerian context, based on the views of academics and students. This concept of academic inquiry is not new; for example, a US study used both academic and student views to investigate BIM pedagogical challenges in construction management programmes (Woo, 2007). However, the concept of BIM adoption in the AEC curricula of developing countries is a relatively new notion and, as such, studies in this area are rare. The findings of Publication 8 are thus germane in gathering a complete and wide-ranging perspective on the challenges of BIM education in undergraduate QS programmes.

The results of the factor analysis in the study described in Publication 8 revealed that the six mostly highly ranked barriers to the incorporation of BIM education into QS curricula are: the extent of the culture change required; inadequate setting/enabling environment; resistance from staff and a lack of industry experts; the non-existence of accreditation standards/requirements; the significant investment required in terms of cost, and the huge security risk. These results strongly resonate with the findings of previous studies with respect to the challenges of integrating BIM in AEC curricula and QS degree programmes. It also aligns with the findings of the CHOBE QS seminar IX report as contained in supplementary Publication S2. The CHOBE workshop, held at Birmingham City University in 2012, was attended by students, academics and industry experts. The report analysed the delegates' views on how to educate quantity surveyors to meet future needs and found similar challenges.

Thus the contribution to knowledge of Publication 8 is three-fold. Firstly, the challenges of BIM integration into AEC curricula are similar for both developed and developing countries and this reflects the global nature of the QS profession. Secondly, the barriers discovered for construction-related curricula are broadly the same as that for the QS curricula and vice versa, which reflects the common struggle of the AEC programmes. Thirdly, the trio of high cost, the human factor in its various forms, and a dearth in recognisable appropriate standards by the PSRBs are critical barriers, which are synergetic. Nevertheless, it is increasingly clear that the appropriate application of BIM theory in practice can foster collaboration among the different disciplines involved in the global AEC industry. Suffice to say that BIM is considered by the body of work presented above to be integrated and multi-disciplinary in nature, more of which follows.

### 4.4 Multi-disciplinary (BIM) education

The influence, or potential future effect, of BIM in the AEC sector and in the academic curricula of related disciplines is profound. Learning methods (such as the project-based method) and learning approaches (such as the collaborative (multi-disciplinary) approach) have been rekindled as a result of BIM usage (Zhao, Sands, Wang & Ye, 2013; Puolitaival & Kestle, 2018). Puolitaival and Kestle (2018) who carried out a data rich global study on the BIM factor in global AEC education concluded that multi-disciplinary delivery models have been encouraged due to the collaborative nature of

BIM. They professed that BIM has allowed the development of experiential learning in AEC programme curricula. BIM enables students to work collaboratively with other disciplines on simulated projects or on authentic tasks in order to solve complex practical problems in a real world setting; hence why Scott (2015) argued that collaborative multi-disciplinary education can be confined to the constructivist view of learning where AEC educators act as learning coaches to students rather than as expert transmitters of knowledge.

In view of this, Macdonald and Mills (2013) asserted that the current education system of AEC professionals does not reflect the real world where they will be expected to work as part of a multi-disciplinary team to solve complex problems. Traditionally, students are often educated independently of other disciplines, by specialist academics who work in silos, with no multi-disciplinary learning or interdisciplinary studies built into the programme curricula (Wood, 1999). This results in an industry which does not fully harness the benefits of the integrated project delivery (IPD) which BIM offers (Macdonald & Granroth, 2013). Soetanto, Childs, Poh, Austin and Hao (2012) agreed with the fact that construction is a multi-disciplinary activity which requires truly integrated collaborative design and construction. Soetanto *et al*. thence concluded that future BE professionals should be educated against this backdrop and to this end. This can help to bridge the divide between the different AEC disciplines and between the industry and HE, since none of these really exists in a vacuum (Scott, 2015). According to Wijnia, Kunst, van Woerkom and Poell (2016), team learning typical of multi-disciplinary education can also help to achieve CBE, which is particularly important in the vocationally focussed AEC sector.

In drawing together the discussions on the importance of collaboration for future construction professionals in the industry, Publication 9 was concerned with gathering QS students' perceptions of multi-disciplinary learning at a UK university. The results of that study provide reflections on a collaborative multi-disciplinary learning project offered as a compulsory module in the School of the Built Environment (University of Salford) and studied at level 5 by architecture, architectural technology, quantity surveying, construction project management, building surveying, and real estate and property management students. The questionnaire which was used to glean QS students' views was initially developed by the Behaviours4Collaboration (B4C) team, which comprised both academic and industry practitioners. Indeed, the concept of using students' perceptions in academic inquiry is not new; this was used by Shelbourn *et al.* (2017) to explicate a UK and US perspective of BIM education implementation in HE.

The findings of Publication 9 show knowledge gaps in all the key areas where an individual has to be collaborative either as a project leader and/or as a project contributor. The more damming results of the study showed that nearly half of the students perceived collaborative behaviours to be of low importance despite the wave of transition initiated by the multi-disciplinary (BIM) education revolution. In addition, Publication 9 also found that whilst construction industry and BE education should, by their very nature, endorse collaborative multi-disciplinary approaches (CMDA) and ways of working, it is only recently through the entrance of BIM into the market and, thus, the recent growing awareness that this is slowly starting to materialise. If this (i.e. the gradual endorsement of CMDA in industry and academic practices) is still the most palpable effect of BIM, then that can only be a good thing in a multifaceted construction environment renowned for fragmentation and adversarial relationships.

Even though the opinions expressed in Publication 9 are obviously limited to a select group of students within a single BE school, it does reflect the progression of thinking from the industry and academia as explicated in the findings from the existing literature.

## 4.5 Summary

The BIM/multi-disciplinary education domain is a huge one and the body of work presented in this thesis covers only part of the ground. Nevertheless, it does add to the understanding of BIM implementation in practice and the understanding of educational challenges and collaborative learning, particularly in the QS context which is the focus of this thesis. On the BIM implementation front, industry sees project level factors (such as the need to improve project outcomes) as the most important drivers while academics perceive firm level factors (such as innovation by firms to gain competitive advantage and maintain a good company image) as the key motivating factor of BIM usage in the industry. This is despite the general perception that an industry level factor such as government push, at least in certain countries such as the UK and US, is the main driver.

With respect to BIM integration into AEC curricula, it is concluded that the educational challenges encountered are similar for both developed and developing countries and this reflects the global nature of the QS profession. Also, the barriers discovered for construction-related curricula are broadly the same as that for the QS curricula and vice versa, which reflects the common struggle of AEC programmes. Additionally, the trio of high cost, the human factor in its various forms, and inconsistent standards/global accreditation are critical barriers, which are synergetic.

Finally, in regard to multi-disciplinary (BIM) education, there are still knowledge gaps in all the key areas where future QS practitioners have to be collaborative. A significant proportion of these major actors in the future construction industry view collaborative behaviours to be of low importance despite the wave of transition initiated by the multi-disciplinary (BIM) education revolution. This implies that more still needs to be done in this area. It also reinforces the need for AEC courses to continue the shift from the narrow-minded and specialisation-oriented model, which has dominated and plagued the sector for some time, to more pluralist (blend of education and training) and multi/inter/trans-disciplinary (collaborative BIM) curricula in the future.

# Chapter 5: Contribution to Knowledge and Conclusion

## 5.1 Summary

Detailed conclusions have been drawn from the various publications presented in this thesis based on their individual research and subjects of investigation. These have been considered together with the observations and findings from other benchmark studies within the three aspects (competence-based education, education for sustainable development, and BIM and multi-disciplinary education) of this critical review and have been summarised (sub-sections **2.5**, **3.5** and **4.5**).

The main findings linked to competence-based education, as explicated in Publications 1-3, are related to the general dissatisfaction with the competency attainment of QS graduates due to a tripartite pull (from industry, academics and professional bodies) on their training needs and to the absence of an agreed threshold benchmark and, thus, there is a need for appropriate improvement in the education and training of future quantity surveyors. Whilst the latest RICS accreditation policies might be a timely intervention in addressing some of these issues, as they stand, the minor changes will only bring about minor changes in outcomes.

The principal conclusion of this thesis with respect to education for sustainable development (as further revealed in Publications 4-6) is that there is no formal mapping process or a set threshold standard for integrating a reasonable level of sustainability education into undergraduate construction curricula. In this context, a lack of definition and common agreement on what sustainable development should entail is causing different interpretations by HEIs and hindering the development of a structured QS curriculum. Additionally, this has important implications for the relevant PSRBs which set the requirements for the QS role and education.

Regarding BIM and multi-disciplinary education (explored in Publications 7 and 8), the trio of high cost, human factors, and inconsistent standards are synergetic critical barriers. Despite the general perception that governmental push is the main driver for BIM implementation in practice, industry sees the need to improve project outcomes while academics perceive the need for firms to gain competitive advantage as the key motivating factors. This thesis ascertained from Publication 9 and the literature findings that there are knowledge gaps in the collaborative behaviours of future QS experts despite the wave of transition initiated by the multi-disciplinary (BIM) education revolution.

## 5.2 Contribution to knowledge

One tangible output of the portfolio of publications submitted, particularly Publication 3, is a competency mapping framework (CMF) which includes the graduate competency threshold benchmark (GCTB). This has been used to maximise RICS policy in education and is reflected in their latest accreditation policy published in 2019; thus the benefits are yet to be seen/reported. Future research will no doubt investigate this. Another main output of the published works is a sustainability framework which identifies QS-related knowledge areas (as seen in Publication 4) and provides a set of well-structured concepts that can be used for modelling sustainable curricula.

The overarching aim of this thesis was to investigate the development of QS undergraduate programmes in order to better prepare students who will meet stakeholders' expectations regarding practice. The contribution to knowledge of this PhD by publication is gained from the refinement of the three main themes contained within the portfolio of published works submitted. The following three sections, thus, summarise the achievements of the thesis and propose recommendations for improvement.

***Competence-based Education***

In order to produce satisfied graduates capable of meeting future demands, there is a need to close the gap between what industry wants and what academia provides. Since accreditation requirements provide the best incentive for curriculum development as established in the literature, and in order to address the failure of previous policies uncovered in Publications 1-3, it is proposed that the RICS should set a minimum threshold benchmark for undergraduate programmes that is agreed with industry practitioners and employers of QS graduates. The minimum standard, which can use the developed GCTB as a starting framework, should use measurable outcomes to reflect the level of competence and the extent of training required by QS graduates to overcome critical challenges and meet the future demands of the industry. The minimum standard should inform the development of an adaptable competency-based curriculum that can adapt to the needs of the ever-changing industry.

#### *Sustainable Development Education*

A sustainability threshold benchmark like the GCTB (see Publication 3) is required for the further integration of sustainability literacy into QS education and to redress the skills gap in practice. This can build on the sustainability framework developed (in Publication 4 and tested/utilised in Publications 5 and 6) but it is necessary to ascertain both the industry requirements and employers' expectations from new graduates through the ranking of the importance of the identified sustainability themes in the framework. A minimum standard which aligns professional body, academic and industry views and allows for innovation should produce competent graduates with the required level of knowledge and skills in sustainability.

#### *Multi-disciplinary (BIM) Education*

In addition to fulfilling RICS competency requirements and that of other relevant PSRBs, the QS profession and education has to accept emerging opportunities and overcome the critical challenges presented by BIM and sustainability in order to remain relevant in the 21st century and to meet future industry demands. The idea of multi-disciplinary (BIM) and team learning, which was explored in Publications 7-9 and other associated studies in this field, is that it should help students to develop a broader appreciation of the importance of their discipline in CBE, to understand how it relates to others in the wider built environment sector, and to achieve the greater goal of integrated, collaborative design and construction which offers sustainable development benefits. Also, such learning should help to move away from the speciality and insularity of the typical BE discipline to more pluralist and multi-disciplinary curricula in the future.

The above recommendations under the three themes are bold and necessary changes, none of which can thrive without impetus from outside academic circles. The PSRBs and government have an important role to play to this end and to bring the fragmented stakeholders together. Such changes should address the everlasting dichotomy between academic provisions and industry needs/expectations, between theory and practice, and between education and training that has plagued the built environment and the QS discipline.

## 5.3 Conclusion

The aim of this thesis is to assist QS educators in curriculum and programme design/development. This has been achieved through reflection on the current QS education and skill requirements as well as on the critical challenges that are driving the future industry needs and emerging roles in the profession. The findings from this thesis have implications for QS degree programmes which cut across the BE/AEC disciplines, HEIs and national boundaries. From the body of work presented, which includes findings from the literature and the publications submitted, this thesis outlines the conclusions formed to date about the development of undergraduate programme curricula. It also provides a useful contribution to knowledge through appropriate recommendations and describes where future research would make an impact.

Even though this study focussed on the built environment, especially QS education, it is anticipated that some of the recommendations made in this thesis could be applied more broadly in other disciplines for programme alignment and improvement. Indeed, construction curricula that both equip professionals for future industry demands/global trends and better prepare graduates to meet present employers' struggles/expectations will survive and maintain their continuing relevance. Such an education, which can be achieved through effective curriculum design and benchmarking, will enhance graduate employability and produce highly fulfilled graduates. This, then, is where the thesis attempts to make a meaningful contribution to knowledge through the proposed recommendations.

Reflecting on the above can help to draw together the three themes of this thesis, which are: competence-based education, education for sustainable development, and BIM and multi-disciplinary education. The following ultimate conclusion can, therefore, be drawn. A truly multi-stakeholder perspective should be used for the development of BE programme curricula rather than the old-fashioned, traditional top-down approach which is clearly not working. As seen in the findings from the literature and the published works, the current approach involves academic institutions designing their curricula to meet the relevant QAA subject benchmark and the PSRBs' competency requirements (primarily developed by just a handful of academics and practitioners, at best). In view of this, the following ultimate recommendation can, thus, be proposed. A holistic and autonomous national syllabus that allows for flexibility and continuous improvement (in keeping with any future competencies) should be negotiated with all affected and interested stakeholders. These stakeholders should include relevant professional bodies, major industry representatives and employers from different sectors, HEIs and recent graduates of the discipline.

Unlike the QS competency requirements expected by RICS (2018a) and RICS (2018b), which only have a subtle emphasis on (and references to) an advisory ability on sustainability and BIM (under generic competencies), these two specialist knowledge areas, dubbed as future competencies (*inter alia* the global trend), should be treated as technical core and primary QS skills. Essentially, further knowledge and experience in these subjects are germane to meeting the future needs and demands of a dynamic, multi-disciplinary construction industry, and the undergraduate QS curricula of HEIs must be developed to reflect this.

The education versus training debate is, no doubt, a consequence of the long existing problematic relationship between academia and practice and this is likely to continue for some time. Therefore, the immediate underlying challenge for QS education providers is redefining the concept of CBE with respect to finding the right balance between the RICS competency requirements and future industry demands regarding BIM and the sustainability agenda. This thesis provides some thoughts for further reflection and can serve as a useful consideration or framework on the conceptualisation and development of effective QS undergraduate programmes for the education and training of future professionals using the developed GCTB (in Publication 3), sustainability model (in Publication 4), and Behaviours4Collaboration map (in Publication 9).

## 5.4 Recommendations and future research activities

This section highlights a collated list of recommendations from the thesis, without being verbose or repetitive, as follows.

- Since accreditation requirements provide the best incentive for curriculum development, and in order to address the failure of previous policies, it is proposed that the RICS should set a minimum threshold benchmark for undergraduate programmes that is agreed with industry practitioners and employers of QS graduates;
- A sustainability threshold benchmark (i.e. a minimum standard which aligns professional body, academic and industry views and allows for innovation) such as the GCTB is required for the further integration of sustainability literacy into QS education and to redress the skills' gap in practice;
- The QS profession and QS education have to accept emerging opportunities and overcome the critical challenges presented by BIM and sustainability in order to remain relevant in the 21st century, to meet future industry demands and to move away from the speciality and insularity of the typical BE discipline to more pluralist and collaborative multi-disciplinary curricula in the future;
- A holistic and autonomous national syllabus that allows for flexibility and continuous improvement should be negotiated with all affected and interested stakeholders to enhance graduate employability and student satisfaction. These stakeholders include relevant professional bodies, major industry representatives and employers from different sectors, HEIs and recent graduates of the discipline.

The above recommendations can and should, of course, inform future research activities. As shown in the list of recommendations, it is vitally important for major stakeholders (especially PSRBs and industry practitioners/AEC employers) to come together to mutually agree on the perceived and expected competency levels for graduate quantity surveyors. Thus, future research may be needed on how to approach, and foster, this much needed collaboration and alignment of views. Whilst the latest RICS accreditation policy (RICS, 2019) addresses some of the identified issues regarding the lack of a defined graduate competency level, further studies should be conducted to investigate the concomitant changes in graduate outcomes. Also, future research should incorporate industry views in any QS-specific (sustainability and BIM) education or learning outcome framework and align academic perceptions with that of the industry regarding graduate level attainments to produce a future-proof threshold benchmark/standard.

## 5.5 Final concluding remarks

This section provides some general observation and personal reflection. The author/researcher, who has led and developed QS degree programmes in several UK universities (including at Oxford Brookes) is currently a key academic member of the Construction and Management Subject Group at the University of Salford as well as the School Academic Misconduct Officer for the built environment. The author is fortunate to be part of (and to have benefited from) the Education and Learning in the Built Environment (ELBE) Research Group. It is reasonable to assume that such groups are not so common nowadays and there are limited scholars in the field. The ELBE research group, which was initiated by Dr Mark Shelbourn, comprises notable academics from far and wide (UK, Republic of Ireland and USA), as well as industry practitioners, all with the common goal of improving BE education in a global and digital AEC sector.

The author's various academic roles to date (with regard to teaching, research, enterprise activities, curriculum development, academic leadership and management) have provided the impetus for this work. Of course, the journey has not always been easy, particularly due to the peculiarities of a PhD by publication and having to combine this work with several other commitments. Nevertheless, the thesis shows the development of the researcher and demonstrates that a recognised standard has been achieved in line with the QAA qualification descriptor and as defined in the UoS Academic Regulations for Research Awards. The thesis also highlights a set of recommendations based on a detailed critical reflection of the body of work presented and outlines where future studies and research can make a further impact and/or break new ground. Overall, a worthwhile and an enjoyable experience, and the author is excited about future prospects.

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# PART B – PORTFOLIO OF PUBLICATIONS

# Annexe A

## Overview of Papers & Declarations of Participation

| Publication Number | Title | Participation statement | Page Number |
|---|---|---|---|
| 1 | Professional, academic and industrial development needs: A competency mapping and expert opinion review | **Professor Srinath Perera (WSU)** This paper investigated the changing developmental needs of Quantity Surveyors who satisfy the aspirations of industrial, professional and academic stakeholders. It provided a full picture of the extent of coverage of competencies in the QS programmes accredited by the RICS. Damilola was engaged with the collection and analysis of data from the four case studies and interviews conducted as well as competency mapping. The methodology/findings/discussion and writing were undertaken jointly with the authors. Editing and reviewing changes to all sections was led by Dami. | 95 |
| 2 | Professional competency-based analysis of continuing tensions between education and training in higher education | **Professor Srinath Perera (WSU)** This paper investigated the expected level of achievement of competencies by QS graduates and the industry perception. Damilola took the lead in writing the initial draft of this paper from the previous research conducted by the | 113 |

| Publication Number | Title | Participation statement | Page Number |
|---|---|---|---|
| | | team. He led the data analysis both on the qualitative and quantitative sides (the questionnaires were a mixture of multiple choice, Likert scale and free text responses). A web survey was sent to 106 QS academics and another survey posted to 2,946 chartered surveyors to ascertain their views. Dami was responsible for the interpretation of the data collected, including statistical analysis. | |
| 3 | Competency mapping framework for regulating professionally oriented degree programmes in higher education | **Professor Srinath Perera (WSU)** Damilola Ekundayo was part of the team who developed a competency mapping and assessment methodology to analyse the compliance of RICS QS programmes to set benchmarks for graduate route. Dami was involved in the (qualitative and quantitative) data collection. He also provided input into the design of the case studies and development of the CMF. The data analysis was carried out mainly by Dami with the drafting and writing of the paper undertaken jointly with the team. | 133 |

| Publication Number | Title | Participation statement | Page Number |
| --- | --- | --- | --- |
| 4 | Mapping sustainability in the quantity surveying curriculum: Educating tomorrow’s design economists (Book Chapter) | **Professor Chika Udeaja (LSBU)** These papers identified the quality and quantity of sustainability-related materials within the built environment curriculum, mainly QS degree programmes. The goal, as initiated by Dami, was to identify broad & specific changes needed to develop competencies relevant to QS practices. Dami’s contributions include: background literature review in the area of sustainability education, mapping, semi-structured interviews/gaining ethical approval, arranging and carrying out the interviews, data analysis, and development of the sustainability framework. | 161 |
| 5 | Sustainable development in a construction related curriculum – quantity surveying students’ perspective | **Professor Chika Udeaja (LSBU)** This paper assessed the level of QS students’ knowledge and identified knowledge gaps in QS–relevant sustainability knowledge areas. Dami was responsible with me for designing and putting together the first draft of the paper, providing guidance for the processing and interpretation of the survey data, editing and reviewing the final paper. Dami’s expertise in this | 176 |

| Publication Number | Title | Participation statement | Page Number |
| --- | --- | --- | --- |
| | | field and contribution was significant for the publishing of this article. | |
| 6 | Towards the development of a framework for incorporating sustainability education in the built environment curriculum (Conference Paper) | **Professor Chika Udeaja (LSBU)** As the leading authority on education for sustainability and QS competencies within the team, the research question was initiated by Dami and the research was designed jointly between us. The research was jointly designed and Dami undertook the literature review, discussion and conclusion. The drafting of the paper was jointly conducted, with the initial structuring of the paper also being undertook by the authors jointly. | 189 |
| 7 | Analysis of the drivers and benefits of BIM incorporation into quantity surveying profession: Academia and students' perspectives | **Dr Solomon Babatunde (OAU)** This paper identifies the BIM drivers and benefits in relation to the QS profession. It also assesses the perceptions of the academic and students on the ranking of identified BIM drivers and benefits in the order of perceived importance. Dami assisted with the literature review and conclusions sections. Due to his experience and knowledge of the subject matter, he helped with the framing of the | 202 |

| Publication Number | Title | Participation statement | Page Number |
|---|---|---|---|
| | | research questions and objectives, and also did the review of the finished article. | |
| 8 | Barriers to the incorporation of BIM into quantity surveying undergraduate curricula in Nigerian universities | **Dr Solomon Babatunde (OAU)**<br>This paper investigated the barriers to the incorporation of BIM into AEC curricula, in this case for QS undergraduate curricula in Nigerian universities where valuable insights were found. Dami's main areas of input were in the writing of the introduction, part of the literature review and the conclusions sections. Dami was also in charge of reviewing the paper in the final write up.<br>This study has opened some other doors to further research with Mr. Ekundayo as co-investigator. | 219 |
| 9 | Collaborative multi-disciplinary learning – quantity surveying students' perspective (Publication accepted and now in production) | **A/Professor Mark Shelbourn (BCU)**<br>This paper offers reflections on a collaborative multi-disciplinary learning project at a University in the North West of the UK, with architecture, architectural technology, building surveying, construction project management, quantity surveyors, and real estate and property management | 239 |

| Publication Number | Title | Participation statement | Page Number |
|---|---|---|---|
| | | students, albeit with a QS focus. Damilola did the majority of the work so I had an overview of it and helped digest the findings. Dami also carried out the processing, statistical analysis and interpretation of the data collected on this research project. He was responsible for writing the findings and discussion as well as the conclusions and future research sections for the paper. | |

# Annexe B

## Supplementary Reports and Acknowledgements

| Report Number | Title | Acknowledgement | Page Number |
|---|---|---|---|
| S1 | RICS professional competency mapping framework for programme appraisal and benchmarking (RICS Research Report) | Part of research team | 279 |
| S2 | Analysis of the delegate survey: How to educate quantity surveyors to meet future needs (CHOBE Project Report) | Co-author | 359 |

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# PROFESSIONAL, ACADEMIC AND INDUSTRIAL DEVELOPMENT NEEDS: A COMPETENCY MAPPING AND EXPERT OPINION REVIEW

**Srinath PERERA [1] ✉, John PEARSON [2], Damilola EKUNDAYO [3] and Lei ZHOU [4]**

[1] *Northumbria University, Ellison Place, Newcastle upon Tyne NE1 8ST, United Kingdom*
*E-mail: srinath.perera@northumbria.ac.uk*
[2] *Northumbria University, Newcastle upon Tyne NE1 8ST, United Kingdom*
*E-mail: john.pearson@northumbria.ac.uk*
[3] *Northumbria University, Newcastle upon Tyne NE1 8ST, United Kingdom*
*E-mail: damilola.ekundayo@northumbria.ac.uk*
[4] *Northumbria University, Newcastle upon Tyne NE1 8ST, United Kingdom*
*E-mail: lei.zhou@northumbria.ac.uk*

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**ABSTRACT.** There is a tripartite pull from academics, industry and professional bodies on the development needs of the Quantity Surveyor (QS). At best, there is scope for misunderstandings between the stakeholders as to what is being required and what is being achieved. At worst there may be actual gaps in the education and/or training being offered and some discrepancies between the levels of attainment. This research sought to review the Royal Institution of Chartered Surveyors (RICS) QS competencies and their application in the delivery of QS degree programmes. The changing development needs of QSs who satisfy the aspirations of industrial, professional and academic stakeholders were investigated through content analysis of the views of an expert forum consisting of relevant stakeholders and a series of competency mapping case studies. The study revealed that there are considerably different standards right across the RICS accredited QS programmes with respect to coverage of competencies. It is concluded that there is no standard benchmark in achieving competencies and it is open to individual interpretation. Further research in the development of a Graduate Competency Threshold Benchmark is suggested to align the disparate views of the stakeholders to accommodate changing development needs.

**KEYWORDS:** Competency mapping; Graduate quantity surveyor; QS degree programmes; RICS QS competencies; Stakeholders

**REFERENCE** to this paper should be made as follows: Perera, S., Pearson, J., Ekundayo, D. and Zhou, L. (2013) Professional, academic and industrial development needs: A competency mapping and expert opinion review, *International Journal of Strategic Property Management,* 17(2), pp. 143–160.

## 1. INTRODUCTION

Quantity Surveying is the profession that is well established in the British Commonwealth as being responsible for the management of cost and contracts in the construction industry (RICS, 1971, 1983; Male, 1990; Pheng and Ming, 1997; Bowen et al., 2008; Ling and Chan, 2008). The profession is also known as Construction Economics in Europe and Cost Engineering in the Americas and parts of Asia (Rashid, 2002; Pathirage and Amaratunga, 2006; Smith, 2009). The academic, professional and training needs of Quantity Surveyors are pulled by three different stakeholders in three different directions (Figure 1). Academics are


**Figure 1.** Key stakeholders influence on quantity surveying education

interested in producing a rounded graduate with the basic foundation of knowledge for further development whereas professional bodies are interested in graduates who can be progressed to full professional status through the achievement of the required core competencies (RICS, 2009a and 2009b; Perera and Pearson, 2011). The industry is looking for a graduate who can straight away contribute both to the daily functions of business activity and to its growth. Hence, there is a tripartite pull on the development needs of the Quantity Surveying Graduate. The present education system of the Quantity Surveyor does not recognise these multi-directional needs and hence often produces a graduate whom the industry sees as not fulfilling their requirements (Wong et al., 2007; Lee and Hogg, 2009; Perera and Pearson, 2011). This leads to many problems, with greater levels of employer and graduate dissatisfaction and obstacles to early career development of the QS graduate.

These conflicting concerns have long fuelled the "education versus training" debate and some conflict between Educators and Employers through which the RICS steers a sometimes difficult path. On the one hand it sends messages to the universities that it wishes to see programmes which lean more towards the "academic" rather than the "technical", whilst on the other hand it sends messages to employers that they should accept graduates issuing from its accredited degree programmes as being appropriately qualified to take positions at higher than technician grade (for which the RICS itself has a specific training route via the HND/Foundation Degree). This can create ambiguities and wrong impressions to the industry, creating conflicts in expectations. For its own part, the RICS has created a set of Core Competencies which, if they are to be fully achieved by candidates for membership, requires active cooperation between the academic sector (providers of basic subject knowledge and certain academic skills) and the industrial sector (providers of practical skills training) through the operation of their business.

### 1.1. Current needs of quantity surveying graduates

Significant growth in undergraduate level education of Quantity Surveyors stems from the late 1960's and early 1970's with the switch from Diplomas in Quantity Surveying, firstly to Ordinary degrees and, within a few years, to Honours Degrees. From the 1971 RICS report "The Future Role of the Quantity Surveyor" (RICS, 1971) identifying specific competencies at the time, the profession began to evolve rapidly and in 1983 a further report was produced, "The Future of the Chartered Quantity Surveyor" (RICS, 1983) as if to further consolidate the professional status of the QS. Just over twenty years ago, with the publication of the document "QS2000" (Davis Langdon and Everest, 1991) there was recognition of a number of forces acting on the QS profession, highlighting both the changes to the client body and to the construction industry (Fan et al., 2001a, 2001b; John, 2002; Fellows et al., 2003; Rick, 2005; Cartlidge, 2006; Ling and Chan, 2008; Senaratne and Sabesan, 2008; Maidin and Sulaiman, 2011).

Both the RICS and the educational sector show similarities in their lack of appreciation of the specific requirements industry may have of its newly graduated student members. At the same time the industry does not seem to appreciate that a graduate is a person with higher intellectual capacity to rapidly further develop their professional skills and technical knowledge once in employment (Perera, 2006; Lee and Hogg, 2009; Simpson, 2010). This conflict and lack of alignment of industry, academic and professional perspectives create a barrier to the development of the profession as well as the career development of the graduate Quantity Surveyor.

Added to this is a more fundamental failure on the part of all parties to appreciate the dynamics of the market sector. The majority of new graduates appear to be entering more non-traditional quantity surveying routes (Perera, 2006; Perera and Pearson, 2011). It has been shown both through research (Perera, 2006) and through records of 1st destination Surveys (UNN Returns, 2001–2008) that a large majority of new graduates find employment not in Private Consultancy Practice (PQS) or the Public Sector, as was the case until the mid 1980's, but with Main Contracting and specialised subcontracting organisations. Perera (2006) shows that in the University of Ulster more than 80% of graduates either seek employment or prefer to be employed in the non-PQS sectors of the industry. The situation is very similar in many other universities in the UK. Feedback from Assessment of Professional Competence (APC) workshops has noted a certain Private Practice bias within the presentation of advice, and indeed there is feedback at university level suggesting this. Much of the academic content and the structure of the RICS itself would both seem directed at those employed in the PQS and Government Sector, paying less attention to the skills inherent in the role of the Contractor's Surveyor (Simpson, 2010). For their part, those engaged in developing Quantity Surveying within the construction sector may see this as another barrier to cooperating with the RICS when required. This is evident from the fact that RICS membership does not grow in the same proportion to the growth in Quantity Surveying student numbers (Perera, 2006). The emergence of Commercial Management (Walker and Wilkie, 2002; Lowe and Leiringer, 2006) as a distinct discipline encompassing the role of the contractor Quantity Surveyor is a fact that the RICS should consider in detail in its future development of career paths for the Quantity Surveyor. Leading Quantity Surveying professional bodies the world over have already begun to recognise these developments and trends. For example, recently the Australian Institute of Quantity Surveyors (AIQS) established a separate pathway for contractors' Quantity Surveyors for completing professional qualification.

### 1.2. RICS assessment of professional competence

The competence-based education initially started in nursing education in the 1970s (Trivett, 1975; Ewens, 1979; Cowan et al., 2007) and gained popularity in many other disciplines in formal and informal education and training all around the world over the last forty years (Mole et al., 1993; Meyer and Semark, 1996). Professional accreditation bodies in the built environment have also been advocates of a competency-based approach (Newton, 2009).

The entry of graduates and others into any professional group of the Royal Institution of Chartered Surveyors (RICS) as fully qualified Chartered surveyors comes only after they have successfully passed the Assessment of Professional Competence (APC). This is true of the Quantity Surveyor, the specific subject of this study, as much as for any other. Key to this is the demonstration, by the candidate, of their having attained certain competencies determined by the Education and Membership Board of RICS. In the case of the graduate, these competencies will have been acquired both through their formal university education and the workplace training which they have received, whether as part time students in employment or during a work placement. In either case, the applicant will have undertaken a period of full time employment beyond graduating, further adding to the in-service training element of their overall skills profile.

It will be appreciated that there is a balance to be struck between the level and type of competence which should be expected, and can be achieved, in the universities and that which arises out of exposure to experience only available within the workplace. To some extent the two must be complimentary, as they should be, and it has emerged over the years that both Academia and Industry have certain expectations of one another, rightly or wrongly, as to what the other can and will achieve as a vehicle for graduate learning. These last are encapsulated, for some, in the arguments within the "education versus training" debate that has dogged the relationship for as many years as formal Quantity Surveying education has existed. From the above it will be seen that, at best, there is scope for misunderstandings between the stakeholders as to what is being required and what is being achieved. At worst there may be actual gaps in the education and/or training being offered and received or, at least, some discrepancies between the levels of attainment.

In summary, it is suggested that the present education system of the Quantity Surveyor does not recognise the multi-directional needs of the Quantity Surveyor and hence often produces a graduate whom the industry sees as not fulfilling their requirements. A further factor in the willingness on the part of the Industry to accept and train new graduates must be resource constraints born of the financial insecurity of the current economic recession, and being experienced severely by existing Members who might otherwise be more willing to accept the risks and responsibilities of employing and training new recruits. This paper is aimed at investigating the changing developmental needs of Quantity Surveyors who satisfy the aspirations of industrial, professional and academic stakeholders through the analysis of the views of an expert forum consisting of academics, industry and professional body representatives. The research also sought to review competencies and their application in the delivery of QS programmes by mapping all 24 RICS QS competencies against curricular for four RICS accredited QS Honours degree programmes reported as four case studies to provide a full picture of the extent of coverage of competencies in the programmes accredited by the RICS.

## 2. RESEARCH METHODOLOGY

The research was carried out in three distinct data gathering phases culminating in data analysis and reporting. The key stages and process are detailed below.

### 2.1. Review

A detailed literature review was carried out to identify the RICS QS competencies and their interpretation.

### 2.2. Competency mapping case studies

A detailed competency mapping exercise was carried out based upon four RICS accredited quantity surveying programmes offered by four leading universities. This involved mapping RICS QS competencies to the individual module specifications of the respective QS programmes. These are referred to as mapping case studies.

### 2.3. Expert forum

This was the catalyst for the identification of key issues related to academia, industry and the RICS. An expert forum consisting of ten specialists was established. A series of interviews were carried out firstly to identify key issues and subsequently these were used to verify the findings of the competency mapping case studies. The forum comprised three academics (programme leaders), three consultant or project quantity surveyors (PQS), three contractor or commercial quantity surveyors (CQS) and one RICS representative (member of the RICS Education and Qualification Standards).

### 2.4. Analysis and survey results

The content analysis of the interviews conducted and the competency mapping case studies provided a detailed account of the primary areas of investigation listed below:

1. RICS Quantity Surveying Competencies.
2. Role of the Quantity Surveyors & Developments.
3. Quantity Surveying Education.
4. Modes of study & placement.
5. RICS Routes of Membership & Training.
6. Role of the RICS.

The RICS QS competencies were analysed in two different ways:

1. Mapping competencies to RICS accredited programme curricular.
2. Establishing the expected level of achievement of competencies by graduate quantity surveyors.

The outcomes related to each of these aspects are discussed in detail in the following sections.

## 3. RICS QUANTITY SURVEYING COMPETENCIES

### 3.1. RICS QS competency requirements

The RICS Competencies are arranged into three groupings, depending upon their perceived relevance to the Role of the Quantity Surveyor:

1. **Mandatory Competencies:** personal, interpersonal and professional practice and business skills common to all pathways [into membership] and compulsory for all candidates.
2. **Core Competencies:** primary skills of the candidate's chosen [RICS] pathway.
3. **Optional Competencies:** selected as an additional skill requirement for the candidate's chosen [RICS] pathway from a list of competencies relevant to that pathway. In most cases there is an element of choice.

The RICS distinguish between three possible levels of attainment in each of a range of competences when setting its requirements of those seeking membership. Briefly, these are as follows:

- **Level 1:** Knowledge (theoretical knowledge).
- **Level 2:** Knowledge and practical experience (putting it into practice).
- **Level 3:** Knowledge, practical experience and capacity to advise (explaining and advising).

There are 10 Mandatory competencies, 7 Core competencies and 7 Optional competencies (two only of these last to be selected by the candidate). The RICS stipulates that an APC candidate needs to achieve all Mandatory competencies at Level 2 or above, all Core competencies at Level 3 (except one not relevant to specialisation depending on employment in consulting or contracting practice which is at Level 2) and 2 Optional competencies at Level 2 or above.

### 3.2. Competency mapping method

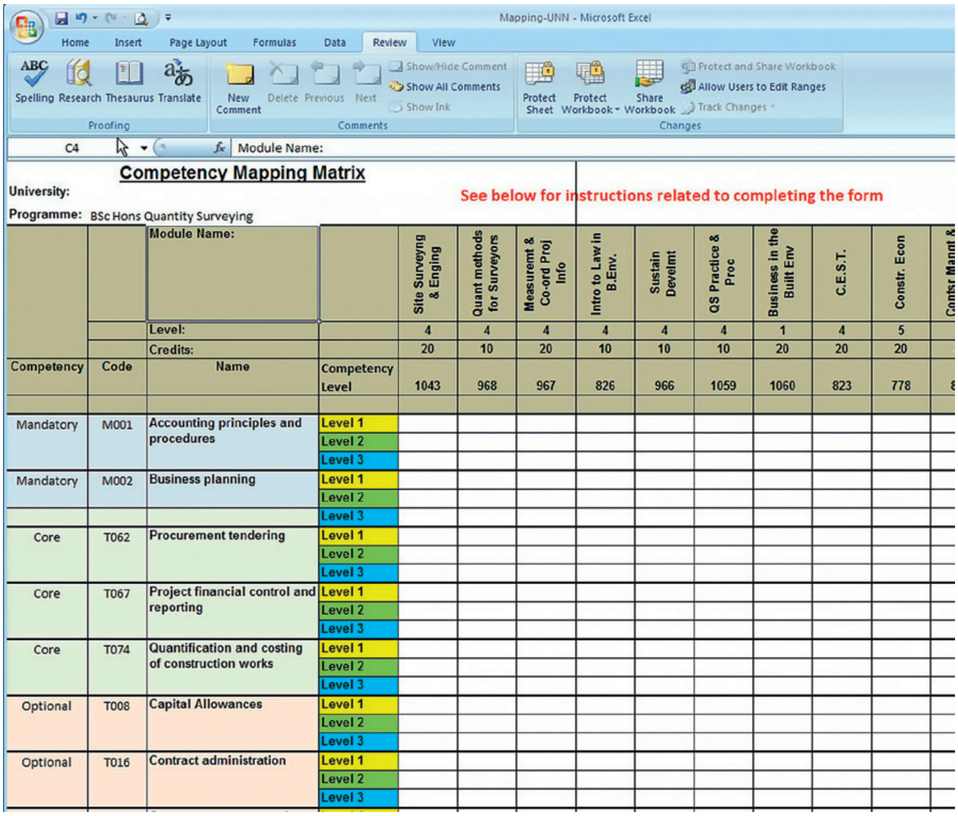
The main method of competency mapping involved the use of a two dimensional matrix comprised of QS competencies on the Y – axis (vertical listing) and Programme specifications on the X – axis (horizontal listing). Each competency was subdivided into the three Levels (1 to 3). Figure 2 illustrates an example of this mapping matrix created as a protected spreadsheet form.

A detailed map scoring system (Table 1) was devised to enable indication of perceived levels of achievement of competencies through the evaluation of the individual module specifications pertaining to a programme.

**Table 1.** Map scoring system

| Score criteria | Score |
|---|---|
| Achieves small parts of a competency | 0.25 |
| Partially achieves a competency | 0.5 |
| Considerably achieves a competency | 0.75 |
| Fully achieves a competency at respective level | 1.00 |

The respondents completing the form were required to make judgements as to what



Competency Mapping Matrix

University:

Programme: BSc Hons Quantity Surveying

See below for instructions related to completing the form

| Competency | Code | Name | Competency Level | Site Surveyng & Enging | Quant methods for Surveyors | Measuremt & Co-ord Proj Info | Intro to Law in B.Env. | Sustain Develmt | QS Practice & Proc | Business in the Built Env | C.E.S.T. | Constr. Econ | Contsr Mangt & |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Module Name: | | | | | | | | | | | |
| | | Level: | | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 5 | |
| | | Credits: | | 20 | 10 | 20 | 10 | 10 | 10 | 20 | 20 | 20 | |
| Competency | Code | Name | Competency Level | 1043 | 968 | 967 | 826 | 966 | 1059 | 1060 | 823 | 778 | 8 |
| Mandatory | M001 | Accounting principles and procedures | Level 1 | | | | | | | | | | |
| | | | Level 2 | | | | | | | | | | |
| | | | Level 3 | | | | | | | | | | |
| Mandatory | M002 | Business planning | Level 1 | | | | | | | | | | |
| | | | Level 2 | | | | | | | | | | |
| | | | Level 3 | | | | | | | | | | |
| Core | T062 | Procurement tendering | Level 1 | | | | | | | | | | |
| | | | Level 2 | | | | | | | | | | |
| | | | Level 3 | | | | | | | | | | |
| Core | T067 | Project financial control and reporting | Level 1 | | | | | | | | | | |
| | | | Level 2 | | | | | | | | | | |
| | | | Level 3 | | | | | | | | | | |
| Core | T074 | Quantification and costing of construction works | Level 1 | | | | | | | | | | |
| | | | Level 2 | | | | | | | | | | |
| | | | Level 3 | | | | | | | | | | |
| Optional | T008 | Capital Allowances | Level 1 | | | | | | | | | | |
| | | | Level 2 | | | | | | | | | | |
| | | | Level 3 | | | | | | | | | | |
| Optional | T016 | Contract administration | Level 1 | | | | | | | | | | |
| | | | Level 2 | | | | | | | | | | |
| | | | Level 3 | | | | | | | | | | |

**Figure 2.** Competency mapping matrix form

amount of a competency at which Level (Levels 1, 2 or 3) was achieved by each module of a programme.

### 3.3. Mapping process

Competency mapping to programme specifications was carried out in 3 stages:

1. Scoring the mapping matrix by the researchers.
2. Scoring the mapping matrix by programme directors of the respective programmes.
3. Consensus adjustment of scoring by the researchers to eliminate bias.

This three stage process established the final scores for competency mapping to programme specifications which were then used for the evaluation explained in this paper.

Programme Directors of the programmes selected as case studies were requested to complete the matrix form based on their judgement of the level of attainment of competencies. These case studies are referred to as Case study A, B, C, and D. Each was asked to allocate approximate scores, at each Level, as defined above, on a scale of 0.25 to 1.00 depending upon their estimation of the coverage they achieved for each of the RICS Mandatory, Core and Optional Competencies through delivery of the modules making up their Undergraduate Quantity Surveying Programme. Through this exercise total scores were achieved in respect of each of the above competencies for each University, together with totals relating to all Modules delivered. The scoring carried out by the programme directors was reviewed by the researchers through a discussion process to achieve a consensus view on individual module scores. The aim of this process was to eliminate individual bias of the scoring process and to achieve a reasonable degree of uniformity in the interpretation of scores.

The last figure can be split to show total estimated delivery at each of the Levels 1, 2 and 3.

There are three possible levels of analysis; the overall total coverage of all competencies for each University, the split between levels for each University and the individual University's actual coverage of specific competencies. These are each analysed in the following sections.

## 4. COMPETENCES MAPPING CASE STUDIES

### 4.1. Overall total coverage of all competencies by universities

There are some variation between the universities studied. Two Universities return total scores of 45 to 48, as against the others who both score 37, a difference between the two pairs of 25%. This would seem to be a significant variance, given that all are offering broadly the same overall programme of delivery and assessment, within broadly similar timescales, and all leading to the same award.

**Table 2.** Total mapping score comparison

| Total score | | | |
|---|---|---|---|
| University A | University B | University C | University D |
| 45.25 | 37.25 | 37.75 | 48 |

### 4.2. Inter-level split across universities

The aggregated level of competency mappings for each university is evaluated in Table 3.

The main reason for the high level of variance between total coverage of competencies (Table 2) is the level of variance built in due to different volumes of coverage at Level 1. Both Level 2 & 3 scores are very similar between universities. This suggests that they have a similar appreciation of the significance of the value of the higher two levels required of new graduates by the RICS. As would be expected, in all cases the total score for Level 1 far exceeds that for Level 2, and that for Level 2 is far in excess of that for Level 3. Level 3 hardly features at all, as one might expect, for it is a competency level only expected of candidates at the time they come to sit their APC, one year or more after graduating.

**Table 3.** Final scores by competency level

| Cumulative level score | | | | |
|---|---|---|---|---|
| Level | University A | University B | University C | University D |
| Level 1 | 32.5 | 27 | 26 | 37 |
| Level 2 | 12.25 | 10 | 11 | 11.25 |
| Level 3 | 0.50 | 0.50 | 0.25 | 0.50 |

### 4.3. Coverage of specific competencies by universities

This section examines the coverage of competencies at the three different levels by the programmes studied. These are analysed separately for Mandatory, Core and Optional competencies.

#### 4.3.1. Coverage of mandatory competencies

Mandatory competencies generally can be expected to be achieved at Level 1. Figure 3 shows how each university performed in coverage at Level 1.

The yellow benchmark line has been set at 1 to indicate sub standard coverage of competencies. A score of 1 or above indicates fully achieving a competency at the respective level. It is clear that there are many competencies (M001, M002, M003, M005, M006 and M008) that have not been adequately covered even at Level 1.

#### 4.3.2. Coverage of core competencies

The coverage of the core competencies presents the most important analysis as these competencies are vital for the function of the quantity surveyor. Figure 4. Core competency mapping scores: Level 1 illustrates the coverage of Core competencies by universities.

When using a benchmark score of 1 all universities have achieved this for all competen-

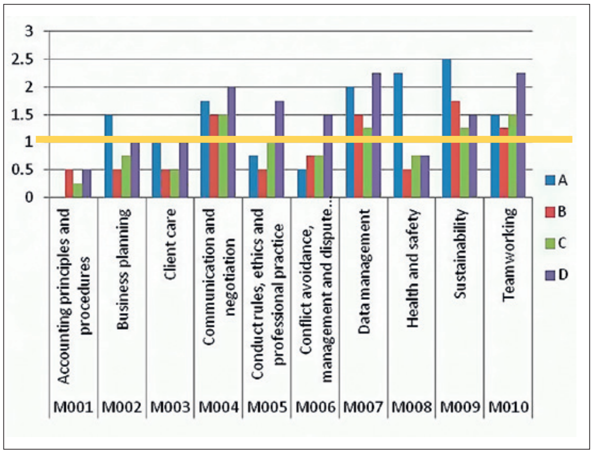



**Figure 3.** Mandatory competency mapping scores: Level 1

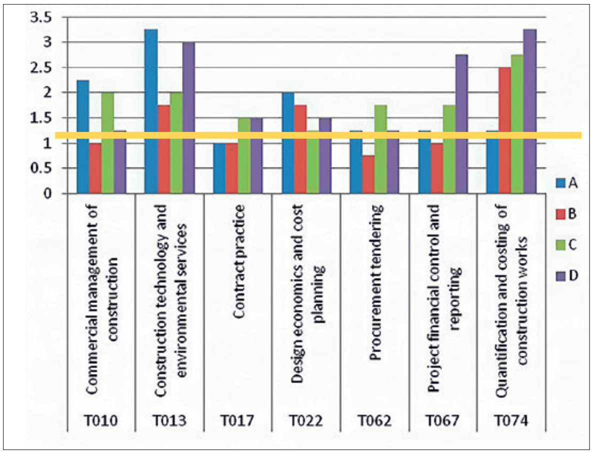



**Figure 4.** Core competency mapping scores: Level 1

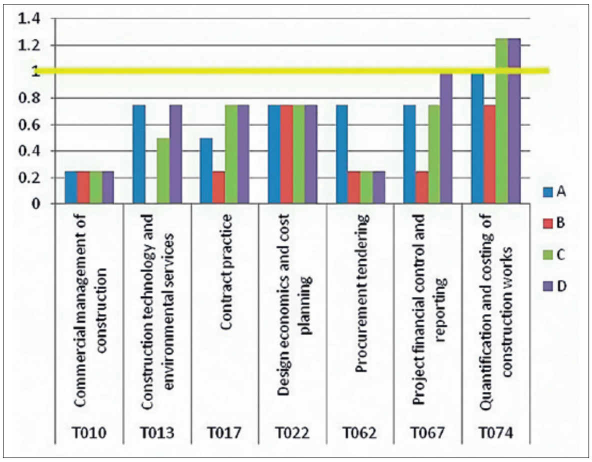



**Figure 5.** Core competency mapping scores: Level 2

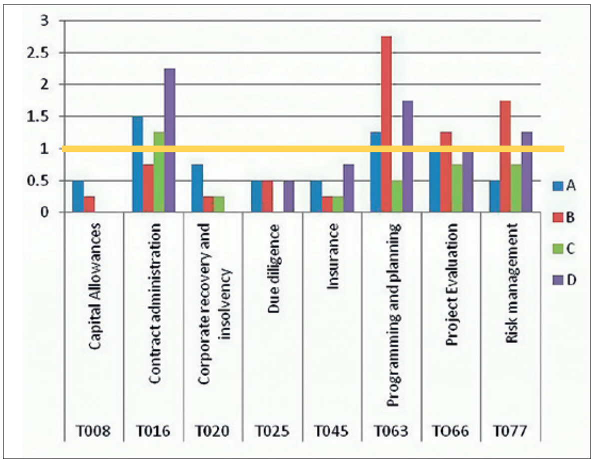



**Figure 6.** Optional competency mapping scores: Level 1

cies. However, as a cumulative score is used this may not fully represent the required level of achievement of a competency.

Figure 5. Core competency mapping scores: Level 2 indicates the core competency coverage at Level 2. It is clear that set against a benchmark score of 1 there is inadequate coverage for all competencies across all universities except for T074 Quantification and Costing of Construction works. The scoring for mapping was carried out based primarily on scoring by programme leaders. In the absence of a detailed specification to indicate what level of content coverage is required for a competency to be achieved, it is difficult to have a uniformly interpreted outcome.

#### 4.3.3. Coverage of optional competencies

Only two Optional competencies are required to be addressed for the APC. However, universities attempt to cover many optional competencies in their curricular often as non-optimal modules. There is no guidance from the RICS as to how many or to what extent (which level) these optional competencies should be completed upon graduation. This is again open to interpretation.

Figure 6. Optional competency mapping scores: Level 1 clearly indicates that all universities do not achieve optional competencies to a benchmark level score of 1.

## 5. VIEWS OF THE EXPERT FORUM

### 5.1. Expected achievement of mandatory, core and optional competencies

The RICS QS competencies provide the basis on which a quantity surveyor will be judged as to their capability to act as an independent, professionally qualified chartered surveyor. The respondents were first asked to consider the competencies in general. The RICS representative noted that there are more prescribed core competencies for QS than for any other pathway. This was however to be combined with the understanding that not every competence need be met by the universities and that the RICS welcomed diversity to reflect the individual strengths of each. Industry CQS respondents noted that the competencies were relevant and "do adequately describe what we want".

A summary of expected level of competency is presented in Table 4. These were extracted from 8 expert forum members who responded to this section. They include 3 academics, 3 CQS and 2 PQS. Also, not all the 8 respondents have graduate level expectation for some Optional competencies such as Capital allowances, Corporate recovery and insolvency, Due diligence and Programming and planning.

The RICS stipulates that an APC candidate needs to achieve all Mandatory competencies at Level 2 or above. Table 4 shows that some of the experts expect graduate QS to have achieved Mandatory competencies at Level 2 or even Level 3. For some competencies such as Communication and negotiation, Data management, and Teamworking, this may be expected due to hypothetical projects and multidisciplinary projects modules involving simulations in most QS degree programmes. But for other competencies such as Business planning, Client care, conduct rules, ethics and professional practice, Health and Safety, etc. it is difficult to see how graduate QS can achieve this through university education.

Table 4 also revealed that most Core competencies are expected to be achieved at Level 2 by graduate QS. It is however worrying that certain academics think that core QS skills such as Design economics and cost planning, Quantification and costing of construction works, etc. should be achieved to Level 1 despite possibilities for learning at Level 2. More worrying is the expectation of a few industry experts who think that graduate QSs should have achieved Level 3 in Commercial management of construction, Construction technology and environmental services, Contract practice, Design economics and cost planning and Quantification and costing of construction works. The RICS stipulates that an APC candidate needs to achieve all Core competencies at Level 3 (except one not relevant to specialisation depending on employment in consulting or contracting practice which is at Level 2). To gain relevant experience and skills, an APC candidate must have worked for 3 years after graduation. Hence it is difficult to see how graduate QSs will have achieved Level 3 as some of the experts anticipated.

Furthermore, the RICS stipulates that an APC candidate needs to achieve two Optional competencies at Level 2 or above in the areas of specialisation. Table 4 shows the experts' expected level of achievement of Optional competencies by graduate quantity surveyors at mainly Level 1 and 2. Whilst the expectation at Level 2 is questionable, it is interesting to see four experts aiming for Level 3 in Contract administration and Programming and planning. The stated competencies are however popular specialisation areas for PQS and CQS respectively hence this is partly expected.

In conclusion, Table 4 shows that there is disparity in the expected level of competency. When viewed in relation to the mapping case studies, there appears to be inconsistency of views of the major construction stakeholders. There are indeed different interpretations of graduate level competency and actual attainment perhaps due to individual understanding of competencies, level definitions and the role of universities in the training of quantity surveyors.

**Table 4.** Summary of expected level of graduate competency

| Competency | Code | Name | Level 1 | Level 2 | Level 3 | Comments |
|---|---|---|---|---|---|---|
| Mandatory | M001 | Accounting principles and procedures | 6 | 2 | | Pure financial statement knowledge as used in accounting is dealt with at a level 1 and 2, but not certainly at Level 3. |
| Mandatory | M002 | Business planning | 7 | | 1 | Several management modules applicable and this is tending towards Level 3. |
| Mandatory | M003 | Client care | 3 | 4 | 1 | This area is certainly covered up to level 2 and it is tending to reach Level 3 due to hypothetical projects and multi disciplinary projects (MDPs). |
| Mandatory | M004 | Communication and negotiation | 3 | 4 | 1 | Management modules, multidisciplinary modules tending to Level 3. |
| Mandatory | M005 | Conduct rules, ethics and professional practice | 5 | 2 | 1 | A “nice to have”: This is covered up to Level 2 within the project work for professional practice and it is tending to Level 3 in the MDP. |
| Mandatory | M006 | Conflict avoidance, management and dispute resolution procedures | 3 | 5 | | Procurement and admin, professional practice at Level 2 and there is no evidence of Level 3 completion for this item. |
| Mandatory | M007 | Data management | 1 | 5 | 2 | Data and information management, discipline projects within the final year dissertation, there is evidence of tending to Level 3. |
| Mandatory | M008 | Health and safety | 3 | 4 | 1 | Not as a core module but the competencies are delivered as parts of modules - law and regulatory frameworks, construction technology etc. |
| Mandatory | M009 | Sustainability | 6 | 2 | | Environmental services in Level 1 and other technology modules tending to Level 2 competency. This area needs development up to Level 3 and important to shape up the future role of the QS. |
| Mandatory | M010 | Teamworking | 2 | 4 | 2 | Aspects of many modules and specifically MDPs. Therefore tending to Level 3. |
| Core | T010 | Commercial management of construction | 2 | 5 | 1 | Construction economics, procurement and admin, estimating and tendering - some of the assessments are tending to Level 3. |
| Core | T013 | Construction technology and environmental services | 2 | 5 | 1 | Level 1 mainly and Level 2. |
| Core | T017 | Contract practice | 3 | 4 | 1 | Up to Level 2 only. |
| Core | T022 | Design economics and cost planning | 3 | 4 | 1 | For PQS’s only; up to Level 2 only. |
| Core | T062 | Procurement tendering | 2 | 6 | | Up to Level 2 only. |

(Continued)

| Competency | Code | Name | Level 1 | Level 2 | Level 3 | Comments |
|---|---|---|---|---|---|---|
| (Continued) | | | | | | |
| Core | T067 | Project financial control and reporting | 2 | 6 | | Up to Level 2 only. |
| Core | T074 | Quantification and costing of construction works | 2 | 2 | 4 | Estimating and tendering at Level 1, measurement under Level 2 and civil engineering surveying at Level 3. |
| Optional | T008 | Capital Allowances | 5 | 1 | | A "nice to have"; not sure about this. This is usually a taxation subject; And other allowances i.e. land remediation relief. |
| Optional | T016 | Contract administration | 3 | 3 | 2 | This is tending towards Level 3; This should be a core competency. |
| Optional | T020 | Corporate recovery and insolvency | 5 | 2 | | This area may be touched upon under financial management. Therefore tending towards Level 2. |
| Optional | T025 | Due diligence | 6 | 1 | | A "nice to have"; professional practice. |
| Optional | T045 | Insurance | 8 | | | As I mentioned, this is an area that needs development for the future of the QS. |
| Optional | T063 | Programming and planning | 3 | 2 | 2 | For Contractors' QS's only; all 3 Levels. |
| Optional | T077 | Risk management | 6 | 2 | | There is wider coverage of the risk and value management in Level 3 of the course and in terms of competencies it will be at Level 2. |

### 5.2. Future role of the quantity surveyor

The interviewees were requested to provide views on the present and future role of the QS. With respect to the present role of the QS they generally agreed that this centred on cost advice, estimating, and measurement. One academic noted that this differed between a contractor's surveyor and a consultant's surveyor though others did not stress the difference. There was some disagreement as to the development of the role of the QS. One PQS noted the role had not changed much whereas one CQS noted it had changed a lot.

### 5.3. Perception of areas of work becoming more important

There was a strong feeling that the role would become more complex, taking more concepts such as sustainability and whole life costing into account. One PQS stated "We are looking at WLC (the whole life cycle) of the facility and its use in a wider context". The importance of WLC was noted by two respondents, one CQS and one PQS. Two respondents (PQS and CQS) suggested that the name QS should change to reflect the function more accurately on the lines of Cost Manager or Cost Engineer. The name change is indicative of observations by other respondents that the difference between PQS and CQS is narrowing and the two roles are merging. The respondents in general indicated the need to up skill the QS knowledge base in use of ICT and its impact on the profession. They also agreed that collaboration and team working would be a more important skill to develop. Sustainability and project management skills were seen as areas for further development whilst civil engineering construction, infrastructure development and mechanical and electrical (energy related) projects were seen as growth sectors for the future.

One PQS was of the view that there is potential for procurement to revert to more traditional methods due to economic pressures. This could be seen as an important possibility that further enhances the cost control role of the QS.

### 5.4. Relative importance of the QS competencies

Four respondents (three CQS, one PQS) noted that there were areas that were not given enough attention or that the students had poor knowledge of; valuation (1), measurement (1), building contracts (1), construction technology (2), M and E services (1), environmental services (1), team working (1), and data management (1).

When queried about possible additional competencies, three respondents (1 PQS, 1 RICS and 1 CQS) identified sustainability, business management and planning, accounting, communication (language, report writing and team working), new building technologies, pre-fabrication, civil and infrastructure engineering, life cycle costing as possible additional competencies. Some of these are already covered in some competencies. Since competencies do not give lengthy descriptions of content, these are open for interpretation.

Three respondents (2 academic, 1 CQS) were happy with the coverage and felt that there should be no new additions to the competencies/skills. One PQS stated that contract administration is listed as optional but felt that it should be core. No respondents felt that there was any obsolete content taught.

### 5.5. Views on quantity surveying education

Six respondents shared their views on the present nature of QS education (1 RICS, 2 academics, 2 PQS, 3 CQS). As class sizes get bigger to make courses more economically viable opportunities for tutors to spend more contact time and give more feedback will be compromised by the numbers of students they have to work with.

One PQS expressed the view that there was too much mass teaching, with a mismatch where the learning outcome does not map to the industry requirement and also felt that some lecturers need to update their knowledge so that the graduates were appraised of the latest techniques. The respondent did however note that it was not possible to make generalisations and there were differences between universities and individual lecturers. One PQS also felt that the RICS had less than adequate involvement in regulating curricular while another CQS felt that although there are many RICS accredited programmes they were not comparable in most respects.

#### 5.5.1. Level of satisfaction with the curriculum used to produce graduate QS

The academic curricular content was commented on by 5 respondents (1 academic, 1 PQS, 3 CQS). The academic noted that they were able to cover a lot of the core competencies in a 4 year degree and that they could map modules that they teach to the core competencies. 2 respondents (1 PQS, 1 CQS) stated that the coverage was pretty good in general terms. However, the industry respondents felt that it was difficult to map modules taught at universities to RICS competencies.

One PQS felt that some courses do not deliver what employers want and one academic stated "students are going out without the necessary skills to undertake their basic job and that is where employees feel that the universities are letting the system down". This being said, the general view was that it is not easy to generalise and some courses are better than others and also it is down to other factors such as the student, mode of study, and employer.

#### 5.5.2. Views on QS programme curriculum development

On aspects of curricular development 5 interviewees responded. Two identified measurement as an area that needs greater attention (1 CQS, 1 PQS). Other areas identified include taxation (CQS), understanding building technology and construction (CQS), bill of quantities (PQS), cost planning, preconstruction estimating (CQS) while there was an overemphasis on management of projects (1 PQS, 1 CQS).The aspect that caused most concern for one PQS was that graduates had a poor understanding about construction technology and no real understanding of on-site conditions. Reflecting on these views it is clear that greater attention is needed to some core areas of quantity surveying. If so, the academics will be faced with the dilemma of identifying which areas to forego in lieu of areas of expansion.

#### 5.5.3. The role of universities in producing a graduate quantity surveyor

All 10 respondents considered what a university should provide with regards to QS education. They were requested to choose between:

1. Provide an overall academic knowledge and a good foundation in Quantity Surveying, or
2. Concentrate on training students for direct QS employment.

Six respondents agreed with statement 1 (2 PQS, 1 CQS, 1 RICS, 2 academics). 2 respondents agreed with statement 2 (1 PQS, 1CQS). One CQS felt that it should be a bit of both, a balance of academia with vocational on a 50/50 basis. One academic was undecided. One CQS stated that over the last 30 years they have seen the quality of technical Quantity Surveying become diluted and warned that if the trend continues we would lose technical standards forever.

In overall terms most wished to see a sound academic background for graduate quantity surveyors but did not want to see any compromise on the level of knowledge. They also seem to expect improved technical competence in graduates going into the industry.

#### 5.5.4. Industry – academia collaboration in QS programme delivery

Two respondents (1 PQS, 1 CQS) commented that there is a reasonable level of employer engagement with the universities. However, the level and extent of engagement is one aspect that requires further exploration.

#### 5.5.5. Industry – academia level of communication

Communications between universities and industry were generally seen to be reasonable although it was added that universities try the hardest and industry needs to be better at communication. The state of the economy was seen as a factor that influences level of communication (1 academic). Greater involvement of the industry as a stakeholder in the development of programmes, face to face industry consultation and industry taking programme development and contributions as part of their corporate social responsibility were seen as steps that can be used to improve the situation.

### 5.6. Modes of study and industry placement

#### 5.6.1. Perceived success of modes of study

The majority of respondents (9) stated that Part Time students were far better and more rounded than full time students, though this was usually in respect of their dedication to work and approach to the job.

#### 5.6.2. Industry placement in quantity surveying education

All 10 interviewees had contributions to make concerning their views on placement. This was unanimously seen as a positive, if not crucial, thing for a student to have. The experience the student gains from having practical experience cannot be replicated in any other way. The current economic situation is having a negative impact on the availability of placements.

### 5.7. RICS membership routes and training

#### 5.7.1. Routes of membership

The RICS QS competencies (learned through education and industry experience) provide the basis on which a quantity surveyor will be judged as to their capability to act as an independent professionally qualified chartered surveyor. Graduate QS can become professionally qualified upon successful completion of the APC after 3 years of post-qualification industry experience. The graduate route is still apparently the most popular route to chartered membership. It is expected to breach the gap between what is learnt at university and what is needed to get chartered. As a result, it is useful to investigate the appropriateness of this membership route and others.

The RICS recently revised their membership pathways.

#### 5.7.2. Level of awareness

Accordingly, two interviewees (1PQS, 1CQS) stated that they are not familiar with the new routes of membership other than the graduate route.

#### 5.7.3. The appropriateness of routes of membership

A total of seven (1 RICS, 2 academic, 2 PQS, 2 CQS) expressed content with the graduate route of membership. One CQS did note that it was sometimes hard to push graduates into becoming chartered, suggesting that this was due to a combination of fee levels and their not seeing any advantage in becoming chartered. Another problem that exists is that more specialised contractors did not give the graduate a wide enough experience in some competencies (1 academic, 1 RICS).

The new Associate pathway was stressed as not being a shortcut to becoming chartered surveyor by the RICS representative. One academic said that it was a nice idea but did not see its relevance and felt that it was not clear enough where the cut off point was between the two levels while another expressed some reservations. One PQS felt that it may lead to people aiming for a minimum standard and that AssocRICS is not good enough to be recognised. 1 CQS noted that it was helpful to people who do not have degrees but to then progress to MRICS or FRICS was a very convoluted route. Another CQS said their company had looked at this route but gone back to the graduate route. These sentiments suggest there is lack of understanding about the new route as well as some doubt as to the need for it.

There was a mixed response to the new Senior Professional route. Three respondents stated that they were not happy with this route. 1 academic viewed it as a “rubber stamping” exercise. One CQS said “my main problem with that route is that it does not test technical competence”. One PQS did not think that people should just be given MRICS for their long experience and although it provides an opportunity to get practitioners into mainstream RICS, they should still fit the APC model and competencies. One academic warned that the RICS have to be careful not to be seen as an institution desperate to get new members in. On the positive side, one PQS noted that it was good and had worked well for them, adding that the CIOB are doing the same thing.

#### 5.7.4. Availability and importance of a structured training programme for APC

The RICS representative noted that unless the company has signed up to the structured training programme they should not take on a graduate for APC. Three respondents (2 CQS, 1 PQS) stated that they did have a structured training programme. One PQS noted that there were very low completion rates for the APC and felt that this was due to very poor levels of basic knowledge, with big gaps between what is learnt at university and what is needed to get chartered. One possible reason for this was seen as employers not considering it as important and that they lack a structured training programme. It was also noted that it is difficult to provide all the training in three years. Smaller companies often struggle as they do not have the volume or frequency of work types to enable them to have a smooth training process. One PQS was highly critical of the APC process itself, stating that it is a daunting process that makes candidates unduly nervous. The RICS process compares with the CIOB less favourably as the CIOB process is friendlier and they help you to get through it.

### 5.8. Views on the role of RICS

#### 5.8.1. Level of communications with the RICS

The level of communication and the respondents’ perception was analysed with respect to RICS Partnerships for programme accreditation, the RICS and Universities, the RICS and Industry communication, Industry and Universities communication.

With specific reference to the communication between the RICS and universities 4 respondents (2 academic, 1 CQS, 1 PQS) made contributions. The 2 academics noted that they had a good rapport with the RICS. The CQS did not know about this while the PQS thought that some had good communication with the RICS and others did not.

The general consensus with respect to communications between the RICS and industry was that it is in need of much improvement, although it is beginning to move in the right direction. There is a need for increase in regional and local level of involvement (2 academic), fees scales need to be more realistic (1 PQS), and RICS needs to be more in touch with leading edge work (1 PQS). Three respondents (1 PQS, 2 CQS) did not really have any contact with RICS through their role in the company with one commenting that RICS has lost its focus on members and become a business instead of an Institution (CQS).

#### 5.8.2. Level of success of the RICS – university partnership agreement

The RICS partnership process was seen as facilitating greater discussion, but most communications still came down to personal relationships. One academic saw the accreditation partnership as a way to understand how the course is being assessed "so that students come out with the ability to be Quantity Surveyors". These indicate the primary role of the RICS partnership agreement as regulating RICS accredited programmes. However, the level and detail of regulation was criticised. One PQS felt that there was a conflict of interest within the RICS Education Board if there were academic members on the board and these influenced its decisions. But, this is questionable as the role of Board is not necessarily to project the view of industry alone. A balanced representation perhaps might be useful. Lack of consultation with the professional group was also noted adding that RICS communication with industry was not good. One CQS did not know about the partnership arrangements. Another felt that there was a real inertia around working out solutions to problems that were identified. There was recognition of the difficulty involved in getting all three parties around the table and keeping the lines of communication open.

## 6. DISCUSSION

The research aimed at investigating the changing developmental needs of Quantity Surveyors who satisfy the aspirations of industrial, professional and academic stakeholders. It used several research instruments to achieve this:

1. Review of RICS QS competencies: provides details of competencies.
2. Competency mapping cases studies involving 4 RICS accredited QS honours degree programmes: indicates how competencies are mapped to programme curricular.
3. Expert views from a forum of experts (industry, academic and the RICS): enlightens on level of competency to be achieved by a graduate and other contextual factors.

The main research objectives sought to ascertain several key aspects related to QS education and development. These are summarised in the following sections.

### 6.1. Summary of the status of RICS QS competencies

The RICS has formulated clear and detailed documentation (RICS, 2009) identifying, classifying and explaining QS competencies. This is primarily aimed at providing guidance to APC candidates seeking full professional membership of the institution. There are 24 QS competencies classified as Mandatory (10), Core (7) and Optional (7). These competencies can be achieved at any of three levels as Level 1, 2 or 3. The RICS defines that an APC candidate needs to achieve all Mandatory competencies at Level 2 or above, all Core competencies at Level 3 (except one not relevant to specialisation depending on employment in consulting or contracting practice which is at Level 2) and two Optional competencies at Level 2 or above.

These competencies form the basis for describing the knowledge-base of the quantity surveyor and at APC to ascertain the level of attainment. Therefore, they should form the basis on which QS degree programme curriculum is modelled. At each programme accreditation the RICS seeks to establish whether the programme in question deals with these competencies. There is no systematic approach or guidance as to what level of competency need be achieved by a graduate completing a RICS accredited programme. At present it is an estimation of whether core competencies are addressed in module specifications.

This process has led to RICS accredited honours degree programmes across the country producing graduates demonstrating considerably varying degrees of competence. It is then left to the employers and graduates themselves to up skill to the required benchmark specified for the APC. What was clearly found in this research is that this process produces a graduate less confident to face the industry and an employer less satisfied than they might otherwise be. This clearly confirms the findings of Lee and Hogg (2009).

### 6.2. Key findings of competency mapping

The main findings related to the competency mapping can be summarised as follows:

1. There is no prescribed threshold benchmark standard for achieving competencies at graduate level.
2. There are no detailed specifications to indicate what content should be covered to achieve a competency.
3. Different universities aim to achieve competencies at different levels, based on their own interpretations.
4. In the absence of a detailed competency specification, the level of achievement of competencies as judged by our own interpretation seems satisfactory for the most part. There are inadequacies in the level of coverage of some competencies.
5. Programme leaders tend to interpret levels of achievement of competencies differently to one another, resulting in apparent differing levels of achievement of competencies and different levels of coverage.
6. There is no standard way to interpret the actual achievement of competencies.
7. There is no formal competency mapping process available for universities in curricular development or revision.
8. Most mandatory competencies are not achieved to a significant extent by the universities studied to date.
9. Core competencies are well achieved at Level 1 based on interpretations made by universities and some attempt made at Level 2. There is greater scope for achieving core competencies to some extent at Level 2.
10. Optional competencies are not reasonably achieved at Level 1 by most universities. Some competencies are however dealt with to a considerably higher level by some universities. There is greater variation across universities.

### 6.3. Views of the expert forum

Most experts were of the opinion that competencies in general should be achieved at Level 1 by graduates. However, some academic experts were of the view that universities achieve more than Level 1 in some competencies and move greatly towards Level 2. One Consultant QS was of the view that both Mandatory and Core competencies should be achieved at Level 2.

The above situation is exactly reflected with respect to the coverage of competencies. There is no uniform view and it is very much open to individual interpretation. These tensions of interpretation are well evident in the above competency mapping case study analysis.

## 7. CONCLUSIONS

The development needs of quantity surveyors are highly influenced by the needs of the industry and profession and shaped by the perception of academia that produces QS graduates to the profession. This research analysed RICS QS competencies and how they are mapped against degree programmes that produce QS graduates. It revealed that there is a huge variation in interpretation of competencies and levels of achievement. The documentation available is inadequate for this purpose probably because it is intended for APC candidate guidance. The competency mapping case studies revealed that there is a high level of variation in the mapping of competencies between programmes especially at Level 1. Although based on the views of programme directors the mapping indicated that most core competencies are well mapped but that there are deficiencies in mandatory and optional competencies. The net result is that there is significant variation in the quality and level of graduates produced by different degree programmes accredited by the RICS. This problem is exacerbated as the programme directors as well as industry experts have considerably varying degree of interpretation of competencies.

The absence of a threshold benchmark that clearly defines graduate level of competence has led the industry to have unrealistic expectations; academia to aspire for unattainable levels of competence, producing a less than satisfied graduate that defies direction.

The expert forum was also used to extract contextual factors that influence industrial, professional and academic development of QS graduates. Overwhelming majority of the expert forum was of the view that the aim of universities' should be to provide an overall academic knowledge and a good foundation in Quantity Surveying as opposed to provide training to produce a QS for the industry.

### 7.1. Limitations

The analysis of competencies was limited to the documents currently available for download from the RICS web portal. The mapping of competencies was limited to opinions of the programme directors moderated through cursory examination of module specifications. Therefore it is possible that there could be a reasonable degree of variation in the outcome of mappings. But the authors are of the opinion that this would not be to an extent that would undermine the overall conclusions derived for the project.

### 7.2. Further research and directions

The focus of the research was to evaluate the views of the two main stakeholders of graduate QS education; the universities and industry. The universities were represented by academics responsible for programme delivery while the industry was represented by consultant (PQS), contractor or commercial (CQS). The views of these stakeholders on the relationship with the RICS were also investigated. There is a considerable degree of differing views and lack of responsibility from all stakeholders, mainly arising out of inaccurate interpretations and lack of definition. This lack of a common benchmark for the interpretation of achievement of competencies by graduates clearly contributes to the dissatisfaction and false expectations on the part of the industry and thus the demoralisation of the graduate. In order to address this situation and thereby align the disparate views of industry, academia and the RICS, further research in the development of a Graduate Competency Threshold Benchmark and the Competency Mapping Framework will be required.

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# Professional competency-based analysis of continuing tensions between education and training in higher education

Srinath Perera
*School of Computing Engineering and Mathematics, Western Sydney University, Sydney, Australia*
Solomon Olusola Babatunde
*Faculty of Engineering and Environment, Northumbria University, Newcastle upon Tyne, UK*
John Pearson
*Department of Architecture and Built Environment, Northumbria University, Newcastle upon Tyne, UK, and*
Damilola Ekundayo
*Department of Real Estate and Construction, School of the Built Environment, Oxford Brookes University, Oxford, UK*

## Abstract

**Purpose** – The education and training of construction graduates are highly influenced by the higher education institutions which produced them and the relevant professional bodies, which set the competencies that guide both academic and industrial learning. Thus, it is important to ascertain what the key stakeholders perceive construction graduates should achieve in competencies. Construction is a practice-oriented collection of professions, thus, this research focussed on the quantity surveying (QS) profession that is responsible for cost control and management of construction projects, and accredited by the Royal Institution of Chartered Surveyors. The purpose of this paper is to identify and analyse the expected level of competencies attained by QS graduates, assess the industry perception of the achievement of competencies by QS graduates, and the ranking of competencies in the order of perceived importance.

**Design/methodology/approach** – The study adopted three different data gathering phases to include literature review, expert forum, and two surveys – industry and academia.

**Findings** – The research revealed unrealistically high expectations by the construction industry of QS graduates achieving a high level of competency in ten mandatory, seven core, and seven optional competencies. The research found that there were significant levels of dissatisfaction with the expected level of achievement of mandatory, core, and optional competencies by the QS graduates. Thus, a perception gap was identified between the academia and the industry.

**Practical implications** – This research will provide a benchmarking tool for curricula alignment for the construction degree programmes in higher education.

**Originality/value** – The identification of the exact nature of industry competencies requirements and any variations will assist the construction graduates to connect more effectively to the industry. These research findings confirm the need for continued expansion of curricula and diversification of pedagogies.

**Keywords** Higher education, Training, Competencies, Stakeholder, Construction graduates

**Paper type** Research paper

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## 1. Introduction

Studies on quality in Higher Education Institutions (HEIs) have received significant attention in the last decade. However, questions remain as to how well HEIs prepare graduates to meet the challenges of constantly evolving and demanding work environments (Holmes, 2001; Hills *et al.*, 2003; Rubin and Dierdorff, 2009). Concerns remain that undergraduate programmes may not be equipping graduates with the key skills needed to gain and maintain employment (Binks, 1996; De La Harpe *et al.*, 2000; Cranmer, 2006; Holmes, 2015). For instance, Maharasoa and Hay (2001) asserted that there is an international concern about the relationship between higher education, employability, and the place of work. Mason *et al.* (2003) and Wilton (2008) claimed that the perceived lack of graduate employability appears rooted in the degree of mismatch between skills acquired in higher education vs those required for employment. This is corroborated by a number of studies in different disciplines. For instance, Azevedo *et al.* (2012) found that employers were not very confident in the level of capability of business graduates in the eight competencies investigated in their study. In engineering education, Male (2010) found gaps between the competencies required for engineering work and those developed in engineering education. Peng *et al.* (2016) found a mismatch between the educational attainment of a graduate with a Master of Engineering degree and the industry needs in China. It is against this backdrop that Nilsson (2010) averred that the role of higher education in the construction and development of the employability of the future workforce has been the subject of debate. This is affirmed by Holmes (2013) that graduate employability has become, and is likely to continue to be, a major issue for a variety of stakeholders in HEIs. Against this backdrop, several studies have been conducted in enhancing the employability of graduates, their preparedness for labour market transition, and the role higher education has in preparing students (see Ropes, 2015; Monteiro *et al.*, 2016; Thang and Wongsurawat, 2016) to mention a few.

Thus, HEIs need to identify different working patterns that graduates might engage in and ensure that they possess employability skills that employers prefer them to possess (Wickramasinghe and Perera, 2010). Ropes (2015) opined that HEIs should develop curricula in collaboration with industry, in order to prepare graduates with competencies that will help them to function effectively in changing work environments. This backdrop necessitated many professional bodies nationally and internationally to develop both the policy and standards for regulating various undergraduate programmes in HEIs. For example, in 2001, the Accreditation Board for Engineering and Technology, the sole agency responsible for accrediting engineering degrees in the USA, specified 11 competencies for their engineering graduates to demonstrate (Accreditation Board for Engineering and Technology, 2008, 2014). Also, in the USA, American Council for Construction Education defines the standards and criteria by which those construction education programmes seeking accreditation or re-accreditation shall be assessed (American Council for Construction Education, 2015). Similarly, in the UK, the Royal Institution of Chartered Surveyors (RICS) – the accrediting body for quantity surveying (QS) and construction programmes, specified 24 competencies, which are grouped into ten mandatory competencies, seven core competencies, and seven optional competencies, when setting its requirements for those seeking membership (RICS, 2009). Further, in the case of their graduate entrants, these competencies will have been acquired both through their formal university education and the workplace training which they have received, whether as part-time students in employment or during a work placement. Also, the Accreditation Council for Graduate Medical Education identified six general competencies in their accreditation criteria (Batalden *et al.*, 2002) among others. Given this, construction, engineering, medical, and other professionally oriented programmes have begun to align their curricula with the outcomes stipulated by their respective criteria (see Batalden *et al.*, 2002; Lattuca *et al.*, 2006).

Therefore, there is an increasing evidence for the need for information about graduates' transition to work shortly after graduation, and graduates' early careers. It is on this premise that this research becomes necessary to ascertain what the key stakeholders' perceived construction graduates, particularly QS graduates, should achieve in competencies. In this respect, this research was guided by the following derived objectives:

- empirically investigate the expected level of achievement of competencies by QS graduates;
- assess the industry perception of the achievement of competencies by QS graduates; and
- ranking of competencies in the order of perceived importance.

It is believed that this research will provide a benchmarking tool for curricula alignment for the construction degree programmes in HEIs. Also, the identification of the exact nature of industry competencies requirements and any variations will assist the construction graduates to connect more effectively to the industry.

## 2. Competence-based education (CBE)

Studies have shown that no greater impulse for learning exists than assessment (see Frederiksen, 1984), thus, a call is growing for the development of assessment methods that can adequately determine competence acquisition (Baartman *et al.*, 2007). For instance, in the knowledge society, HEIs have an important role to play in professional development. Higher education providers have the awareness that design and delivery of study programmes have to comply with industry practice and professional body requirements. The influence of industry on curriculum development is increasingly significant (Mekenzie, 2010). Benner (1984) developed a five-stage professional development model such as novice, advanced beginner, competent, proficient, and expert, which could be used as a competence framework for professional education programmes. CBE initially started in nursing education in the 1970s (Cowan *et al.*, 2007). Over the last 40 years, CBE has been gaining popularity in many disciplines in formal and informal education and training all around the world. Professional accreditation bodies in the construction-oriented degrees have also been advocates of a competency-based approach (Newton, 2009). There are various definitions of competence (Miller, 1990; Eraut, 1994; Parry, 1996; Verma *et al.*, 2006).

Commonly, competence is described as the combination of knowledge, skills, and attitudes necessary in certain job contexts or job situation (Eraut, 1994). CBE should address knowledge, skills, and attitudes in an integrated way since each of these separately is not sufficient for the desired competent professional behaviour (Taconis *et al.*, 2004). Verma *et al.* (2006) stated that the benefits of CBE are to foster empowerment, accountability, and performance evaluation. Evidently, CBE has been widely used in higher education. The competency-based curricula have an integral set-up in which the profession is central (Boyatzis *et al.*, 1996). It aims to assist students in obtaining high qualified professional competencies and increase graduate employability. However, CBE in higher education is not perfect; there are some critics who claim that its diminished process inhibits deep understanding and knowledge capture. Barnett (1994) argued that CBE can lead to loosely designed curricula that undermine the quest for deep understanding. On the other hand, curriculum design has to reflect current industrial practice in a fast changing world.

## 3. RICS QS competency requirements

The role of QS has evolved over the years since its origins in the mid-nineteenth century and more recently through a series of reviews under the auspices of the RICS. The RICS report published in 1971 defined the role of the QS in a succinct and clear manner (RICS, 1971). It sought to establish the profession as specialists in measurement and valuation of construction works. This was then followed by the report on the future role of the chartered

QS in 1983 (RICS, 1983) which identified the skills and knowledge base of the QS while identifying the scope for expansion and diversification of services. A greater level of detail and definition to the role of the QS was brought about by the RICS report on "the core skills and knowledge base of the quantity surveyor" (RICS, 1992). These provided the basis for the development of the RICS (2009) QS competencies. Thus, the RICS (2009) defined the level of achievement of competencies required of the chartered quantity surveyor as follows:

(1) Mandatory competencies: personal, interpersonal, professional practice and business skills common to all pathways (into membership) and compulsory for all candidates.
(2) Core competencies: primary skills of the candidate's chosen (RICS) pathway.
(3) Optional competencies: selected as an additional skill requirement for the candidate's chosen (RICS) pathway from a list of competencies relevant to that pathway. In most cases there is an element of choice, though driven, usually, by their employer's specialism.

Consequently, the RICS distinguishes between three possible levels of attainment in each of a range of competencies when setting its requirements of those seeking membership. Briefly, these are as follows:

- Level 1: knowledge (theoretical knowledge);
- Level 2: knowledge and practical experience (putting it into practice); and
- Level 3: knowledge, practical experience, and capacity to advise (explaining and advising).

There are ten mandatory competencies, seven core competencies, and seven optional competencies (two only of these last to be selected by the candidate). The RICS stipulates that an assessment of professional competence candidate needs to achieve all mandatory competencies at Level 2 or above, all core competencies at Level 3 (except one not relevant to specialisation depending on employment in consulting or contracting practice which is at Level 2) and two optional competencies at Level 2 or above. However, there is no such definition for the level of achievement of competencies for the graduate quantity surveyor (Perera and Pearson, 2011). This has resulted in individuals and organisations interpreting levels of achievement of competencies in their own way. Therefore, the aforementioned RICS QS competencies were adopted for the graduate QS and analysed in the relation to the objectives of this research as follows:

(1) establish the expected level of achievement of competencies by graduate QS;
(2) establish the perceived level of achievement of competencies by graduate QS; and
(3) ranking of competencies in the order of perceived importance.

The analysis and presentation of the findings are guided by aforementioned objectives.

## 4. Research methodology

Previous studies conducted to identify important competencies for professionally oriented graduates, most especially for engineering graduates, surveyed two or more key stakeholders to include the academic staff, industry, or professionals with over five years industrial experience, human resource, line managers, programme directors in HEIs (see Meier *et al.*, 2000; Bodmer *et al.*, 2002; Spinks *et al.*, 2006; Brumm *et al.*, 2006; Male *et al.*, 2011). Also, few studies adopted literature review and conceptualization (see Woollacott, 2009; Male, 2010). Thus, this research adopted a literature review, an expert forum, and two surveys, of industry and academia, culminating in data analysis and reporting. The key stages and process are detailed as follows.

*4.1 Review*
A detailed literature review was carried out to identify the RICS QS competencies and their interpretation.

*4.2 Expert forum*
This was conducted for the purpose of the identification of key issues related to academia, industry, and the RICS. A total of ten interviews were carried out comprising three academics (programme leaders), three consultant quantity surveyors, three contractor quantity surveyors, and one RICS official (member of the RICS Education and Qualification Standards). The views obtained from this forum informed the development of the academic and industry questionnaire surveys. Both surveys were first piloted among a small sample of volunteers representing industry and academia. The review of the feedback obtained through a discussion session led to the modification of the questionnaires.

*4.3 Survey of the academia*
The issues identified from the literature and expert forum formed the basis of the survey questionnaire. The academic survey is one of the two surveys conducted. A comprehensive survey consisting of 41 questions was carried out to ascertain the views of the QS academic community across academic institutions in the UK. According to the RICS, there are 26 universities conducting a total of 51 programmes (31 undergraduate and 20 postgraduate) producing RICS accredited QS graduates. A total of 106 academic staff from all 26 universities which conduct RICS accredited programmes were contacted and web-based survey requests were sent. The survey received 65 responses from which 20 were eliminated due to the incompleteness of responses leaving 45 sets of fully completed survey responses. The survey data analysis is presented using the 45 fully completed survey responses received. The survey achieved response rates of 61 per cent overall and 42 per cent fully completed.

*4.4 Survey of the industry*
The issues identified from the literature and expert forum formed the basis of the survey questionnaire. A comprehensive survey consisting 39 questions was carried out to ascertain the views of the QS industrial and professional community across firms in the UK. This included clients, consulting, and contracting firms representing both the private and public sectors. According to the RICS, there are approximately 7,000 chartered quantity surveyors registered in the UK. The survey was posted to a sample of 2,946 chartered surveyors with high levels of experience randomly selected from the RICS member database. A total of 615 responded from which 314 were eliminated due to the incompleteness of responses leaving 301 sets of fully completed survey responses. The survey data analysis is presented using the 301 fully completed survey responses received. The survey achieved a response rate of 21 per cent overall responses and 10 per cent fully completed survey response rates. This was expected as the survey method did not use prior permission for the survey request which was mainly on a voluntary basis. However, the data sample is quite adequate to carry out an analysis with over 99 per cent confidence level as the population size is large (Bartlett *et al.*, 2001).

## 5. Results

*5.1 Survey respondent profiles*
The survey respondents for both surveys (industry and academia) were exceptionally experienced in QS work, with over 90 per cent have more than ten years professional experience (see Figures 1 and 2). No direct comparison could be made between the natures of the workloads of each group. The academics spent approximately 50 per cent of their time

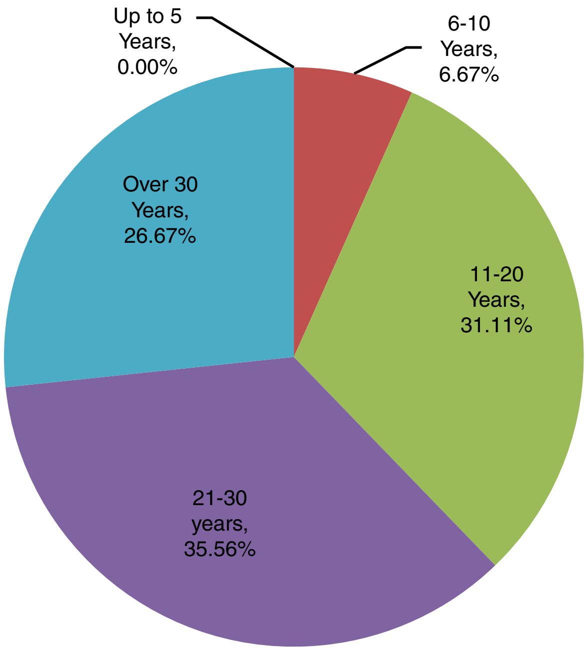



**Figure 1.** Respondent QS experience profile (academia)

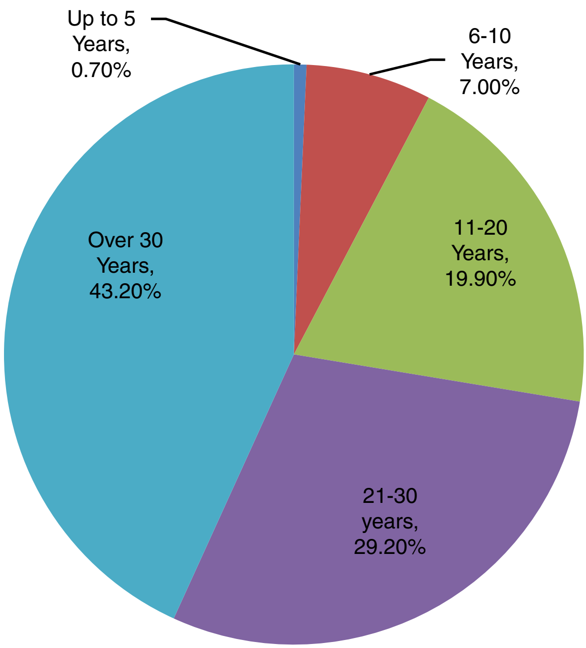



**Figure 2.** Respondent QS experience profile (industry)

engaged in teaching and assessment, followed by administration with 25 per cent and research 15 per cent (see Figure 3 for details). Similarly, 51.80 per cent of the industry respondents were consultants that engaged in private practice. Others include contracting with 17 per cent, the public sector 15 per cent (see Figure 4).

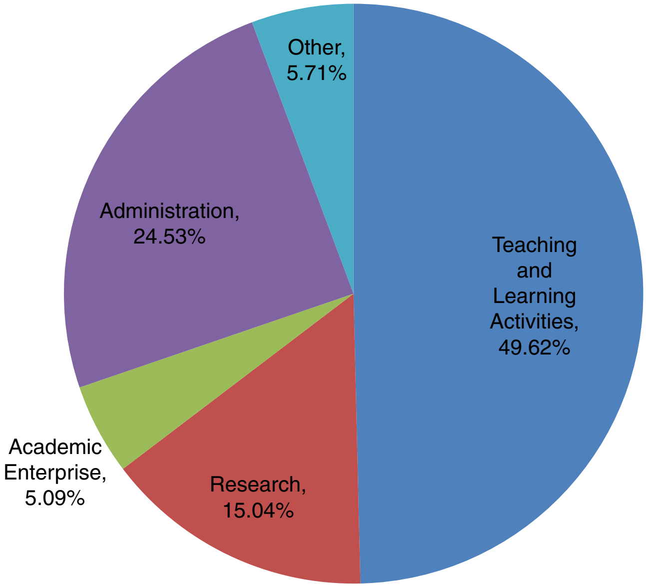



**Figure 3.**
Respondent work profile (academia)

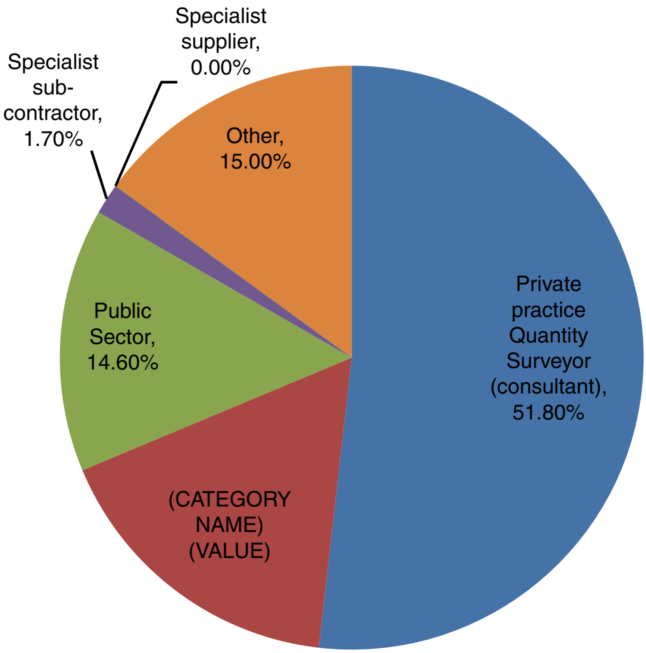



**Figure 4.**
Respondent work profile (industry)

*5.2 Expected level of achievement of competencies by QS graduates*

It is important to ascertain what key stakeholders perceive a graduate should achieve in levels of competency. Thus, this section analyses the views of academics and industry to establish the expected level of achievement of competencies (i.e. mandatory, core, and optional competencies) by QS graduates. Based on Levels 1-3, where:

- Level 1: knowledge (theoretical knowledge);
- Level 2: knowledge and practical experience (putting it into practice); and
- Level 3: knowledge, practical experience, and capacity to advise (explaining and advising).

*5.2.1 Expected level for mandatory competencies*. Figure 5 and Table I reveal the academic responses on the ten mandatory competencies. It indicates that the academic are expecting the highest level of experience to be at Level 2 with 46.44 per cent. For instance, the overall perception of academic on expected levels of mandatory competencies by QS graduates are 37.33, 46.44, and 16.22 per cent for Levels 1-3, respectively (see Figure 5 and Table I for details). Also, Figure 6 and Table I indicate the industry responses, it shows that the industry expecting the highest level of experience to be at Level 1 with 51.76 per cent. For example, the overall views of industry are 51.76, 38.08, and 10.16 per cent (see Figure 6 and Table I for details). In both cases, the highest ratings were given in the areas of M010 Team working, M004 Communication and negotiating, and M007 Data management. It can be deduced that there was the difference in the perceptions of both the academic and industry on the expected level of mandatory competencies by QS graduates. However, both the academic and industry concurred on Level 3 being the least level of experience expected of newly QS graduates.

The final assessment of mandatory competencies was summarised in Table I as follows.

Thus, it is recommended that mandatory competencies be achieved at Level 1 and achieving Level 2 at least in part for some competencies as indicated in Table I.

*5.2.2 Expected level of core competencies*. Figures 7-8 and Table II indicate the perceptions of academic and industry on the expected levels of core competencies. It reveals that the

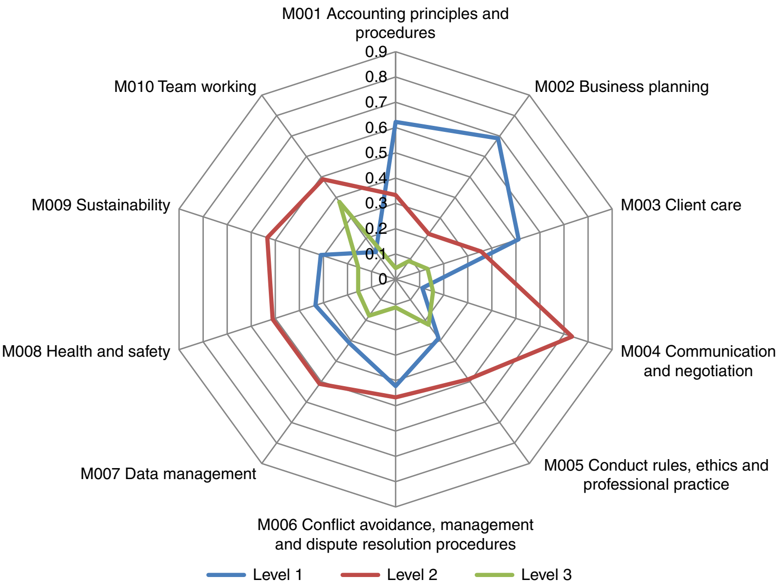



**Figure 5.**
Expected level of achievement of mandatory competencies for new graduate QS (academic)

**Table I.**
Summary of expected levels for mandatory competencies

| Mandatory competencies | Academic Level 1 (%) | Academic Level 2 (%) | Academic Level 3 (%) | Industry Level 1 (%) | Industry Level 2 (%) | Industry Level 3 (%) | Level recommended |
|---|---|---|---|---|---|---|---|
| M001 Accounting principles and procedures | 62.22 | 33.33 | 4.44 | 79.40 | 18.60 | 2.00 | 1 |
| M002 Business planning | 68.89 | 22.22 | 8.89 | 85.00 | 13.00 | 2.00 | 1 |
| M003 Client care | 51.11 | 35.56 | 13.33 | 51.80 | 39.90 | 8.30 | 1 |
| M004 Communication and negotiation | 11.11 | 73.33 | 15.56 | 26.90 | 56.80 | 16.30 | 2 (part) |
| M005 Conduct rules, ethics and professional practice | 28.89 | 48.89 | 22.22 | 41.90 | 37.20 | 20.90 | 1 |
| M006 Conflict avoidance, management and dispute resolution procedures | 42.22 | 46.67 | 11.11 | 60.80 | 32.20 | 7.00 | 1 |
| M007 Data management | 31.11 | 51.11 | 17.78 | 36.20 | 51.20 | 12.60 | 2 (part) |
| M008 Health and safety | 33.33 | 51.11 | 15.56 | 49.50 | 41.20 | 9.30 | 1 |
| M009 Sustainability | 31.11 | 53.33 | 15.56 | 64.50 | 30.20 | 5.30 | 1 |
| M010 Team working | 13.33 | 48.89 | 37.78 | 21.60 | 60.50 | 17.90 | 2 (part) |
| Percentage rank | 37.33 | 46.44 | 16.22 | 51.76 | 38.08 | 10.16 | |

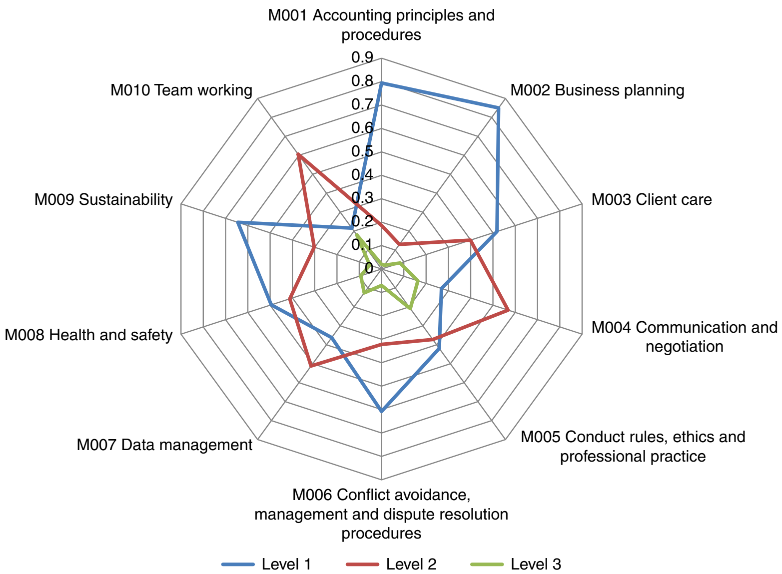



**Figure 6.**
Expected level of achievement of mandatory competencies for new graduate QS (industry)

overall perception of academic on expected levels of core competencies by QS graduates are 14.92, 49.21, and 35.87 per cent for Levels 1-3, respectively (see Figure 7 and Table II for details). In the same vein, the overall perception of industry on core competencies are 23.64, 49.56, and 26.83 per cent for Levels 1-3, respectively (see Figure 8 and Table II for details). It can be seen from the finding that both the academic and industry unanimously agreed on the expectation of attainment at Level 2 of core competencies for new QS graduates (see Table II). Surprisingly, both the academic and industry were expecting a number of core competencies to be achieved at Level 3. For instance, the academic and industry expecting approximately 36 and 27 per cent, respectively, of core competencies at Level 3 (see Table II for details). Thus, expecting these percentages (i.e. 36 and 27 per cent) of

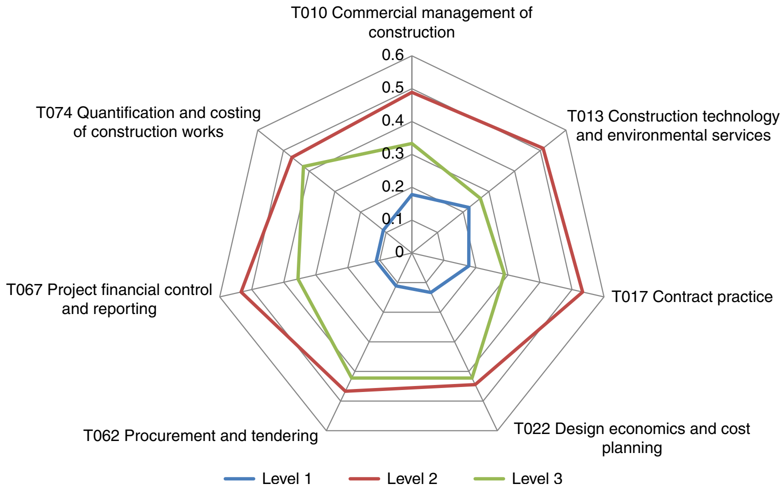



**Figure 7.** Expected level of achievement of core competencies for new graduate QS (academic)

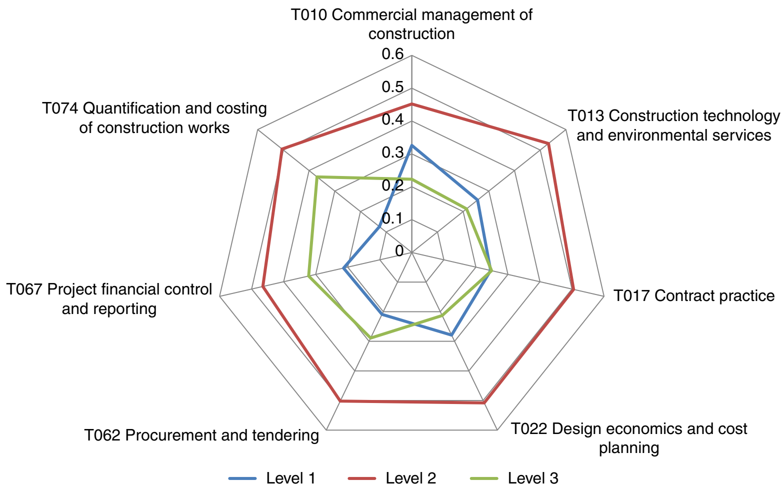



**Figure 8.** Expected level of achievement of core competencies for new graduate QS (industry)

core competencies at Level 3 from new QS graduates indicate that both the academic and industry are exhibiting a wishful thinking. As new graduates are unlikely to be in a position immediately in advising clients, as the acquisition of Level 3 suggests (see RICS, 2009).

The final assessment of core competencies was summarised in Table II as follows.

It is, therefore, recommended that the core competencies be achieved at Level 2 in part as indicated in Table II. This is also justified by the fact that most programmes currently proceed to Level 2 to some extent and have the full capacity to do so (see Table II).

*5.2.3 Expected level for optional competencies*. Figures 9-10 and Table III reveal the perceptions of academic and industry on the expected levels of optional competencies. Thus, the overall perception of academic on expected levels of optional competencies by QS graduates are 52.38, 36.51, and 11.11 per cent for Levels 1-3, respectively (see Figure 9 and Table III for details). In the same vein, the overall perception of industry on expected levels of optional competencies are 69.81, 24.67, and 5.51 per cent (see Figure 10 and Table III for details).

**Table II.**
Summary of expected levels for core competencies

| Core competencies | Academic Level 1 (%) | Academic Level 2 (%) | Academic Level 3 (%) | Industry Level 1 (%) | Industry Level 2 (%) | Industry Level 3 (%) | Level recommended |
|---|---|---|---|---|---|---|---|
| T010 Commercial management of construction | 17.78 | 48.89 | 33.33 | 32.60 | 5.20 | 22.30 | 2 (part) |
| T013 Construction technology and environmental services | 22.22 | 51.11 | 26.67 | 25.60 | 53.20 | 21.30 | 2 (part) |
| T017 Contract practice | 17.78 | 53.33 | 28.89 | 24.60 | 50.50 | 24.90 | 2 (part) |
| T022 Design economics and cost planning | 13.33 | 44.44 | 42.22 | 27.90 | 50.80 | 21.30 | 2 (part) |
| T062 Procurement and tendering | 11.11 | 46.67 | 42.22 | 20.90 | 50.20 | 28.90 | 2 (part) |
| T067 Project financial control and reporting | 11.11 | 53.33 | 35.56 | 21.30 | 46.50 | 32.20 | 2 (part) |
| T074 Quantification and costing of construction works | 11.11 | 46.67 | 42.22 | 12.60 | 50.50 | 36.90 | 2 (part) |
| Percentage rank | 14.92 | 49.21 | 35.87 | 23.64 | 49.56 | 26.83 | |

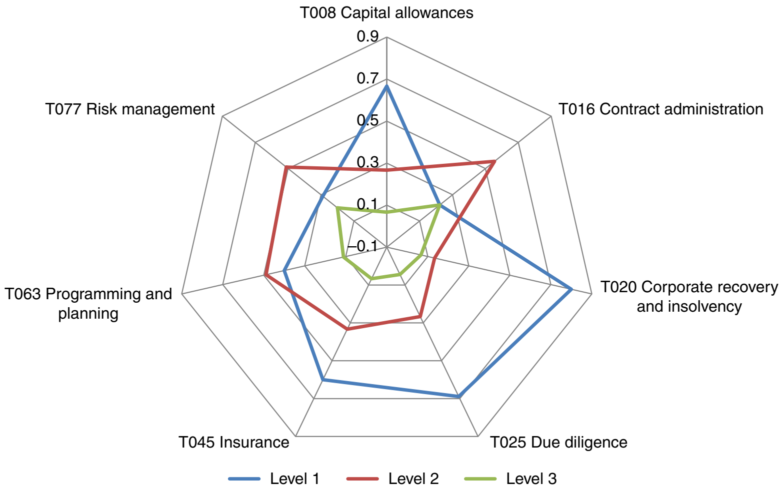



**Figure 9.**
Expected level of achievement of optional competencies for new graduate QS (academic)

It can be seen that both the academic and industry agreed on the expectation of optional competencies for new QS graduates at Level 1 (see Table III for details).

The final assessment of optional competencies was summarised in Table III as follows.

It is recommended that optional competencies be achieved at Level 1 but a few numbers of optional competencies may be extended in part to Level 2 as indicated in Table III.

*5.3 Perceived level of achievement of competencies by QS graduates*

Figure 11 reveals the perception of the industry on the level of achievement of competencies comprising mandatory, core, and optional competencies by QS graduates. However, the perception of academics was not captured because they are actively involved in the development of graduates. Thus, Figure 11 indicates the graduate competency achievement in all the competencies with the mean score values ranging from 2.05 to 2.96. This implies that the industry is partially satisfied with the competencies achieved by the graduates.

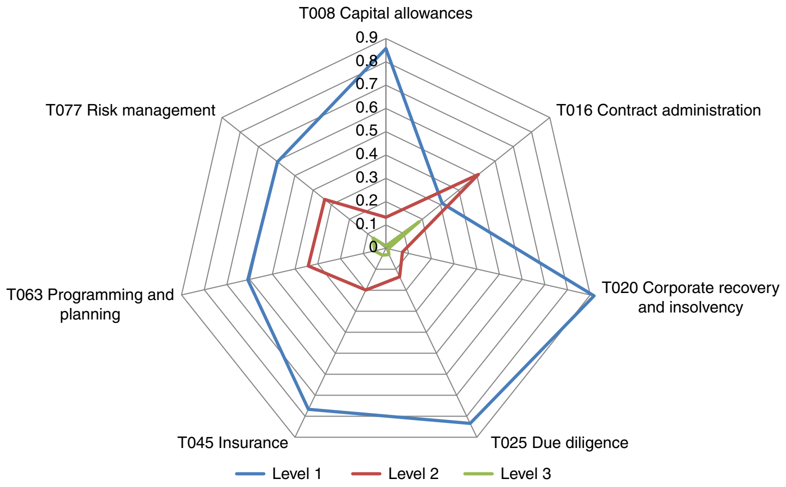



**Figure 10.** Expected level of achievement of optional competencies for new graduate QS (industry)

**Table III.** Summary of expected levels for optional competencies

| Optional competencies | Academic Level 1 (%) | Academic Level 2 (%) | Academic Level 3 (%) | Industry Level 1 (%) | Industry Level 2 (%) | Industry Level 3 (%) | Level recommended |
|---|---|---|---|---|---|---|---|
| T008 Capital allowances | 66.67 | 26.67 | 6.67 | 85.70 | 13.30 | 1.00 | 1 |
| T016 Contract administration | 22.22 | 55.56 | 22.22 | 30.90 | 50.80 | 18.30 | 2 (part) |
| T020 Corporate recovery and insolvency | 80.00 | 13.33 | 6.67 | 91.70 | 7.30 | 1.00 | 1 |
| T025 Due diligence | 68.89 | 26.67 | 4.44 | 83.40 | 13.60 | 3.00 | 1 |
| T045 Insurance | 60.00 | 33.33 | 6.67 | 76.70 | 19.90 | 3.30 | 1 |
| T063 Programming and planning | 40.00 | 48.89 | 11.11 | 60.80 | 34.20 | 5.00 | 1 or 2 (part) |
| T077 Risk management | 28.89 | 51.11 | 20.00 | 59.50 | 33.60 | 7.00 | 1 or 2 (part) |
| Percentage rank | 52.38 | 36.51 | 11.11 | 69.81 | 24.67 | 5.51 | |

Also, it can be seen that ten out of 24 competencies have mean score values between 2.50 and 2.96. These ten competencies comprised six mandatory and four core competencies. The six mandatory competencies are M007 Data management; M010 Team working; M009 Sustainability; M008 Health and safety; M005 Conduct rules, ethics and professional practice; and M004 Communication and negotiation. Similarly, the four core competencies include T022 Design economics and cost planning; T062 Procurement and tendering; T017 Contract practice; and T013 Construction technology and environmental services (see Figure 11 for details).

### *5.4 Ranking of competencies in the order of perceived importance*

Figure 12 reveals the perception of academics and industry on the level of importance of mandatory, core, and optional competencies in QS. Thus, Figure 12 is demarcated into three layers – the upper layer is mandatory competencies, the middle layer is core competencies, and the bottom layer is optional competencies. Therefore, the ranking of these competencies in terms of importance by both the academics and industry are as follows.

*5.4.1 Ranking of mandatory competencies.* As indicated in Figure 12, academics ranked M004 Communication and negotiation; M010 Team working; and M005 Conduct rules,

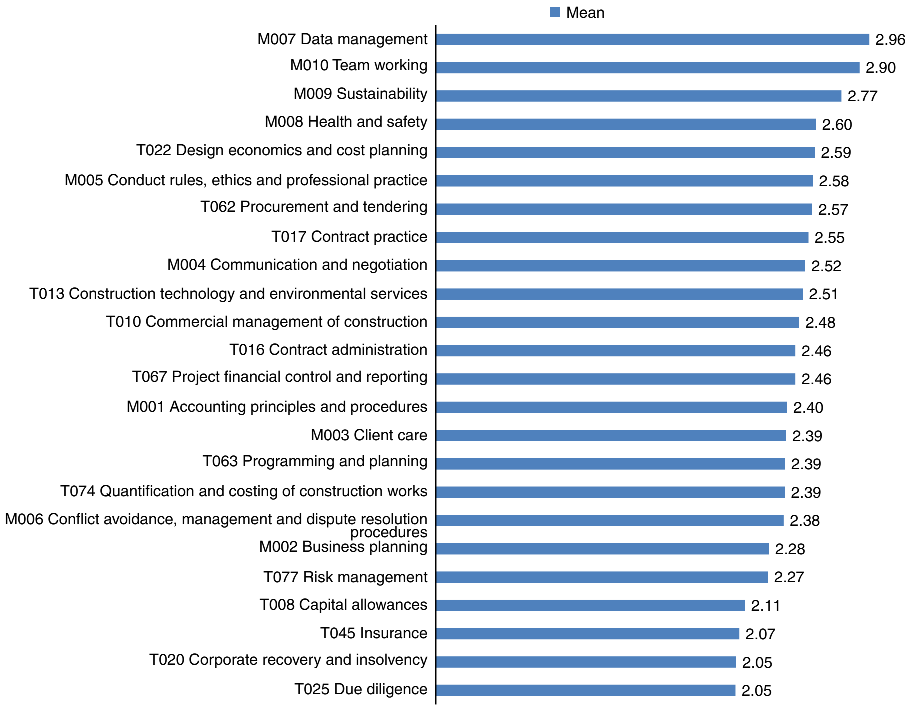



**Figure 11.**
Industry's perception of achievement of competencies by QS graduates

ethics and professional practice above other mandatory competencies and awarded them the highest scores of 5, 5, and 4.5, respectively. In the same vein, industry ranked M003 Client care; M004 Communication and negotiation; M005 Conduct rules, ethics and professional practice; M006 Conflict avoidance, management, and dispute resolution procedures; and M010 Team working higher than others but with a maximum score of 4 (see Figure 12 for details). It can be seen that both academics and industry have a similar perspective on the relative status of mandatory competencies for the most part.

*5.4.2 Ranking of core competencies*. It can be seen from Figure 12 that academics ranked all core competencies equal to the highest rating of 5. Similarly, the industry ranked T062 Procurement and tendering; T067 Project financial control and reporting; and T074 Quantification and costing of construction works the highest with a score of 5, while all other core competencies received a ranking of 4 (see Figure 12). This reflects a more pragmatic ranking considering the industry needs.

*5.4.3 Ranking of optional competencies*. As shown in Figure 12, academics ranked all optional competencies between 3 and 4. While industry ranked optional competencies ranging from 2 to 4 (see Figure 12 for details). Further, both the industry and academics ranked T016 Contract administration and T077 Risk management highest with a score of 4. On the other hand, the least ranked optional competencies are T008 Capital allowances; and T020 Corporate recovery and insolvency with a score of 2 (see Figure 12 for details).

### *5.5 Cross-comparison of levels of expectation, achievement, and importance of competencies*

A cross-comparison of industry perceptions on expected level of competence, the importance of competency, and level of achievement of competency by graduates is cross-plotted to evaluate the relationship with these criteria (see Figure 13). Thus, expected level


**Figure 12.**
Ranking of competencies in the order of perceived importance

has been re-scaled to a 1-5 scale to graphically compared with an importance ranking (scaled 1-5) and perceived achievement (scaled 1-5) (see Figure 13 for details). From this comparison, it is clear that whilst there is high importance attached to a competence, there may be a comparatively lower level of achievement. This is established in this study.

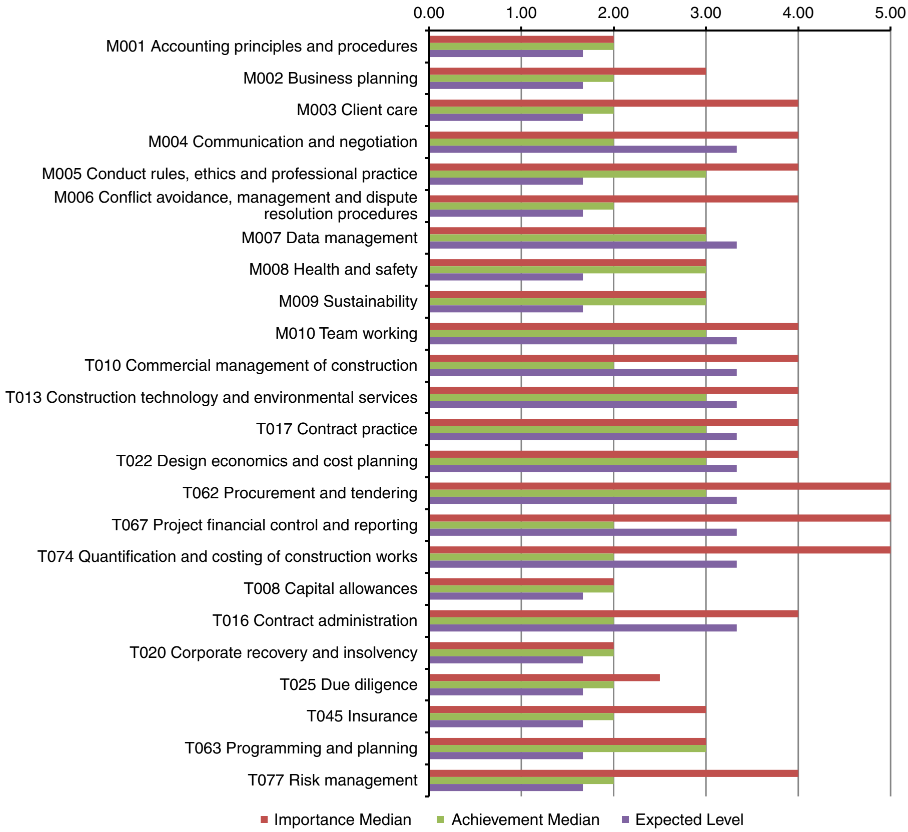



**Figure 13.**
Cross-comparison of competency expected level, importance ranking, and graduate achievement

For example, the competencies that show wider gaps between expectation and achievement are listed as follows (see Figure 13):

(1) M003 Client care;

(2) M004 Communication and negotiation;

(3) M006 Conflict avoidance, management and dispute resolution procedures;

(4) T010 Commercial management of construction;

(5) T062 Procurement and tendering;

(6) T067 Project financial control and reporting;

(7) T074 Quantification and costing of construction works;

(8) T016 Contract administration; and

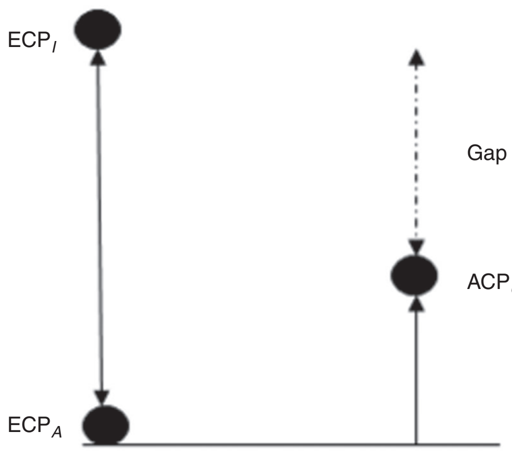
(9) T077 Risk management.

These nine (out of 24) competencies comprised three mandatory, four core, and two optional competencies, respectively, which have a significantly high importance in the role of the quantity surveyors (see Figure 13 for details).

## 6. Discussion

The role of HEIs in providing quality education and training systems that produce graduates that meet the current and future needs of the employers/industry and society at large was recognised. Thus, the purpose of this research was to identify and analyse the expected levels of competency attained by QS graduates; assess the industry's perception of the achievement of competencies by QS graduates, and rank competencies in the order of perceived importance. These research objectives were addressed from a multitude of angles; a literature review, the views of an expert forum, and two surveys – industry and academia. The expert forum consisted of ten members representing private practice (consultants – three), contracting (three), academia (three) and the professional body "RICS" (one). The surveys were comprehensive with the academic survey receiving 45 completed responses from 26 universities producing RICS accredited QS graduates in the UK. The industry survey receiving 301 completed responses representing consultant, contractor, public sector, and specialist quantity surveyors. This approach was similar to previous studies. For instance, Brumm *et al.* (2006) surveyed 212 stakeholders including employers, academic staff, and students when developing and assessing programme outcomes through workplace competencies for engineering students at Iowa State University, USA. Other similar studies that surveyed stakeholders when identifying generic competencies for engineering graduates (see Meier *et al.*, 2000; Bodmer *et al.*, 2002; Male *et al.*, 2011).

This research revealed the 24 QS competencies classified as mandatory (ten), core (seven), and optional (seven) (RICS 2009). These competencies can be achieved at any of the three levels as Levels 1-3 (see RICS, 2009). The RICS QS competencies provide the basis on which the competence of a chartered quantity surveyor is defined. Thus, all the 24 RICS QS competencies were examined in the relation to the study's objectives. Adopting RICS QS competencies was similar to previous studies in construction-oriented degree programmes. For instance, Newton and Goldsmith (2011) collated learning outcome statements for QS and construction from the mandatory and core competencies of the RICS. These research findings revealed unrealistically high expectations by the industry of QS graduates achieving a high level of competency in ten mandatory, seven core, and seven optional competencies. This is illustrated in Figure 14 as follows.




**Notes:** ECP, expected competency profile; ACP, actual competency profile; *I*, industry; *A*, academia; *G*, graduate; ...... perception gap

**Figure 14.** Perception gap in graduate competency

The views of both the industry and academia were logical to some extent on the expectations of Level 1 achievement for the most mandatory competencies and Level 2 for all the core competencies, and Level 1 for the most optional competencies. However, there were some worrying trends with over 35 per cent expecting Level 2 for mandatory competencies, Level 3 for some core competencies and Level 2 for some optional competencies. These far exceed the levels that can be practicably achieved by a new graduate. For example, a Level 3 competency would require experience in advising clients and exhibiting expertise (RICS, 2009). These certainly cannot be achieved in a university (classroom) environment (see Figure 14 for details). The research findings further indicated that there were markedly low levels of ranking of the current state of achievement of competencies by new graduates. On a scale of 1-5, the overwhelming majority indicated the midpoint for most competencies and a score of 2 for others. The scoring was higher for mandatory competencies such as M010 Teamwork, M007 Data management, and M009 Sustainability. All core competencies were ranked much lower, the least satisfaction being shown with core competency T074 Quantification and costing of construction works, followed by T067 Project financial control and reporting. This finding was slightly similar to several studies that identified teamwork as most important amongst the generic competencies for engineering graduates (see Meier *et al.*, 2000; Bodmer *et al.*, 2002; Brumm *et al.*, 2006; Reio and Sutton, 2006; Male *et al.*, 2011). This research concludes that there were significant levels of dissatisfaction with the expected level of achievement of mandatory, core, and optional competencies by the QS graduates. Thus, perception gap was identified between the academia and the industry.

## 7. Conclusions

This research provided the empirical evidence on the competencies expected and attained by new graduates upon entry into an early career in the case of QS profession. In achieving this, several research instruments such as a review, an expert forum, academic and industry surveys were conducted. The results of the academic survey revealed that the academics expected the graduates would reach Level 2 of most mandatory competencies, Level 2 (or 3 in some cases) of core competencies and Levels 1 or 2 of optional competencies. It can be deduced that these far exceed the levels that can be practicably achieved by a new graduate. For example, a Level 3 competency would require experience in advising clients and exhibiting expertise. These certainly cannot be achieved in a university (i.e. classroom) environment. The findings from the industry survey indicated that the competency level expectations of the industry were more pragmatic for the most part. However, there were significant levels of unrealistic expectations with over 35 per cent expecting Level 2 for mandatory competencies, Level 3 for some core competencies and Level 2 for some optional competencies. Also, the research revealed considerably low levels of ranking of the current state of achievement of competencies by new graduates. Based on these research findings, it is established that the current industry competence needs are not being adequately met by graduate competencies falling short of industry expectations. Thus, the HEIs have yet to respond effectively to the current and future challenges in addressing the “mismatch” between the industry expectations and the competencies of graduates in construction-oriented programmes. This research, therefore, advocates greater levels of university and industry collaboration in developing and delivering construction programmes at large in HEIs.

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**Corresponding author**
Solomon Olusola Babatunde can be contacted at: sobabatunde80@gmail.com



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# Competency mapping framework for regulating professionally oriented degree programmes in higher education


**Srinath Perera, Solomon Olusola Babatunde, Lei Zhou, John Pearson & Damilola Ekundayo**



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# Competency mapping framework for regulating professionally oriented degree programmes in higher education

Srinath Perera[a], Solomon Olusola Babatunde[a]*, Lei Zhou[a], John Pearson[a] and Damilola Ekundayo[b]

[a]*Faculty of Engineering & Environment, Northumbria University, Newcastle upon Tyne, UK;* [b]*Faculty of Technology, Design and Environment, Oxford Brookes University, Oxford, OX3 0BP, UK*

Recognition of the huge variation between professional graduate degree programmes and employer requirements, especially in the construction industry, necessitated a need for assessing and developing competencies that aligned with professionally oriented programmes. The purpose of this research is to develop a competency mapping framework (CMF) in this case for quantity surveying honours degree programmes. The graduate competency threshold benchmark (GCTB) is a key component of the CMF. Therefore, the CMF contains the mapping process, the template documents and the benchmark. The research adopted literature review, pilot study, case studies (including semi-structured interviews) and expert forum in developing the framework. The framework developed in this research provides new insight into how degree programmes map against competencies. Thus, the framework can be applied more widely, to other professional degree programmes, for monitoring and improving the quality and professional standards of construction degree programmes by accrediting bodies. This should connect construction graduates more effectively to the industry.

**Keywords:** Competencies; construction; curriculum; degree programmes; higher education

## 1. Introduction

Educational strategies and policies at both the national and global levels contribute significantly to shaping the future direction of many professions and industries. Given the sector's large diversified and dynamic nature, the updating of knowledge and skills for construction graduates becomes imperative. For instance, Keraminiyage and Lill (2013) asserted that studying at higher education institutions (HEIs) is a primary mode of knowledge and skills enhancement for construction professionals. While this mode is broadly received and acknowledged, it has frequently been condemned for its feeble acknowledgement of and connection to the changing needs of industry and its failure to react quickly to emerging knowledge and skills demands (Kaklauskas et al. 2012). It is against this backdrop that Perera and Pearson (2013) stated that any enterprise operating in today's competitive climate should regularly be reviewing potential markets for its products with a view to satisfying these and to long-term

*Corresponding author. Email: solomon.babatunde@northumbria.ac.uk

growth. In this respect, academic institutions are no different. Thus, those responsible for programme development in HEIs should be on the lookout for appropriate areas of expansion and provision must keep pace with the times, and adjust where possible to changing professional needs (Perera and Pearson 2013). To this end, competency-based measures have become an important recourse for identifying and developing potentially realistic and practical training requirements, especially as these measures reflect a cyclical and continuous process of assessing, planning and taking corrective action (Dainty, Cheng, and Moore 2003).

The competence-based education initially started in nursing education in the 1970s (Cowan, Norman, and Coopamah 2007) and gained popularity in many other disciplines in formal and informal education and training all around the world (Meyer and Semark 1996). The significance of competency-based measures in promoting the development of appropriate professional training requirements is well underscored (Tett et al. 2000; Gibb 2003). Therefore, an educational strategy based on competencies has become a norm. For example, a robust competency model helps to align practice and academic priorities. Some earlier studies support this. For instance, Getha-Taylor et al. (2013) argued that competency-based programmes provide students with the knowledge, skills and attitudes necessary for successful careers. Rissi and Gelmon (2014) claimed that the recognition of the substantial variation in professional roles and employment settings that graduates enter necessitated the need to define programme contents that concentrate on creating and assessing competencies that aligned with programme mission and students' career goals. Batterman et al. (2011) stated that educational competencies depict learning objectives and are utilised to plan educational programmes, develop curricula and assess existing programmes. Arain (2010) suggested that the essential competence of a construction programme in the core area of construction project management is in imparting to its students the necessary expertise to practise professionally in the construction industry.

There is a considerable interest in identifying specific competencies for construction-oriented degree programmes. For instance, Ahn, Annie, and Kwon (2012) examined key competencies for construction graduates in the USA. Arain (2010) identified competencies for baccalaureate level construction education in Alberta, Canada. Batterman et al. (2011) studied competencies for graduate education programmes in the energy and sustainability area, among others. In spite of these studies of the competencies required of construction-related graduates in HEIs, there are hardly any studies found in the literature that provide an insight on how modules/courses in undergraduate studies mapped against these. Also, construction industry employers have been vocal in reporting their perception of a lowering of employability of graduates. A recent study investigating the views of both industry and academia concluded that there are significant levels of dissatisfaction with the quality of graduates (Perera and Pearson 2011). It is identified that the root cause of the issue is that graduates produced from different Royal Institution of Chartered Surveyors (RICS) accredited degree programmes in HEIs have significantly different competency levels, often far below what the industry expects. The lack of a mechanism to systematically evaluate programme module content against RICS competencies and a benchmark for graduate competencies is, therefore, considered as the core cause of this problem (Perera and Pearson 2011). This research aims to fill this gap by developing a competency mapping framework (CMF) that comprises the graduate competency threshold benchmark (GCTB) for quantity surveying (QS) honours degree programmes. Achieving this is fundamental to success in aligning the views of industry, academia and the professional body – RICS. In this respect, this research was guided by the following derived objectives:

- Examination of the mandatory, core and optional competencies and benchmarking the expected level of compliance for RICS accredited degree programmes.
- Development of a competency mapping and assessment methodology to analyse the compliance of programmes to set benchmarks for graduate route.
- Development of a competency mapping scoring system to analyse the level of mapping and gaps.
- Development of the final benchmark (i.e. GCTB).

It is believed that the process used to develop the framework can be applied to any professionally oriented degree programme in HEIs. Further, the framework would be useful for the monitoring and management of existing degree programmes in any construction-related discipline. It is anticipated that this research will contribute to improving the understanding of the knowledge and skills context, more efficient alignment of HEI outputs with industrial needs and ultimately to the future positive development of the construction sector at large.

## 2. Subject area descriptions of construction education degrees

Subject area descriptions are best considered as benchmarking exercises for a particular field of study or discipline group (Newton et al. 2012). Construction education in HEIs represents a field of study that encompasses the modern academy such as Architecture, Engineering and Law, among others. It is corroborated by Newton et al. (2012) that the discipline of Building and Construction draws together a substantial range of distinctive academics and professional practice. Thus, at the core of the discipline are a number of discrete professions such as Construction Management, QS, Building Surveying, Facilities Management and Property Development, united through a shared concern with the initiation, provision, operation and sustainability of the built environment (Newton et al. 2012). Construction is a practice-oriented collection of professions. Therefore, the educational unit should establish an effective relationship with the industry (ACCE 2015). This backdrop necessitated the professional bodies nationally and internationally to develop both the policy and practice for construction education. For instance, in the USA, bachelor degree programmes in construction management are accredited by the American Council for Construction Education (ACCE). Thus, ACCE defines the academic standards and criteria by which those construction education programmes seeking accreditation or re-accreditation shall be assessed. In Australia, academic standards for building and construction professions are developed and refined through national consultation involving all relevant professional bodies and higher education providers (see Newton and Goldsmith 2011a). For example, in 2010–2011, the Learning and Teaching Academic Standards project in building and construction established the Threshold Learning Outcomes (TLOs) that all graduates of an Australian bachelor award in building and construction are expected to have met or exceeded (ALTC 2011; Newton 2011; Newton et al. 2012). In the UK, in establishing the benchmark standards for construction, property and surveying, the Quality Assurance Agency (QAA) for Higher Education makes reference to national occupational standards that have been developed by the Construction Industry Council, as well as to the accreditation policies produced by professional bodies such as the

Chartered Institute of Building and the RICS (QAA 2008). Thus, the single honours degree programmes in HEIs in the UK are formulated with reference to the QAA benchmark statements in construction, property and surveying (2008) and accredited by RICS–University Partnership Scheme for which it must meet quality thresholds as identified in the RICS Assessment of Professional Competence (APC) in QS and Construction (2009).

## 3. QS education

QS is a profession that is well established in the British Commonwealth as being responsible for the management of cost and contracts in the construction industry (RICS 1971, 1983; Male 1990; Pheng and Ming 1997; Bowen et al. 2008; Ling and Chan 2008). The profession is also known as construction economics in Europe and cost engineering in the USA and parts of Asia (Rashid 2002; Pathirage and Amaratunga 2006; Smith 2009). Over the years, QS education has evolved from being rather technician related in nature into fully fledged honours degrees with a greater orientation towards commercial management, cost, contracts and project management. In the UK, the current QS degrees grew from the early 1970s with the move from diploma to degree-level qualification for entry to the profession. This transition from diplomas to university degrees was in line with the general transformation of the higher education sector of the British education system. The majority of these degrees were delivered by the former polytechnics, most of which, in turn, became new universities in the early 1990s (Perera and Pearson 2013).

In the UK, the RICS–university partnership agreement is the primary mechanism to ensure the academic quality of accredited programmes. This process involves ensuring that certain minimum standards, known as 'thresholds', as set out in the guidance and policy document on university partnerships are achieved (RICS 2008a). A stipulation regarding relevant employment of graduates was waived off late, due to the current economic situation (RICS 2008a). At present, there is no formal obligation for programme teams to map their curricula against specific RICS QS competencies at specific levels, although most seek this outcome to some extent. The guidance and policy document does list and refer to the APC requirements, suggesting the 'likelihood of meeting threshold standards and leading to an existing APC pathway' as a factor in the accreditation or otherwise of a programme (Perera and Pearson 2013). The 2010 'vision for high-quality education' was set out by an education task force in 1999 (RICS 2008a). This envisaged strong partnerships between the RICS and a limited number of recognised centres of academic excellence, characterised by not only an appropriate range of curricula at undergraduate and postgraduate levels, but also increased freedom for selected universities to develop courses and methods of delivery at all academic levels. This is far from a prescriptive recipe, which lacks consideration of matching specific levels to core competencies. It is against this backdrop that this research developed a GCTB, which led to the development of a final CMF.

## 4. Research methods

The research adopted four distinct data gathering phases, which culminated in data analysis and reporting, to benchmark the expected level of achievement of competencies by the QS graduates produced by RICS accredited programmes. The key stages and process are illustrated in Figure 1.

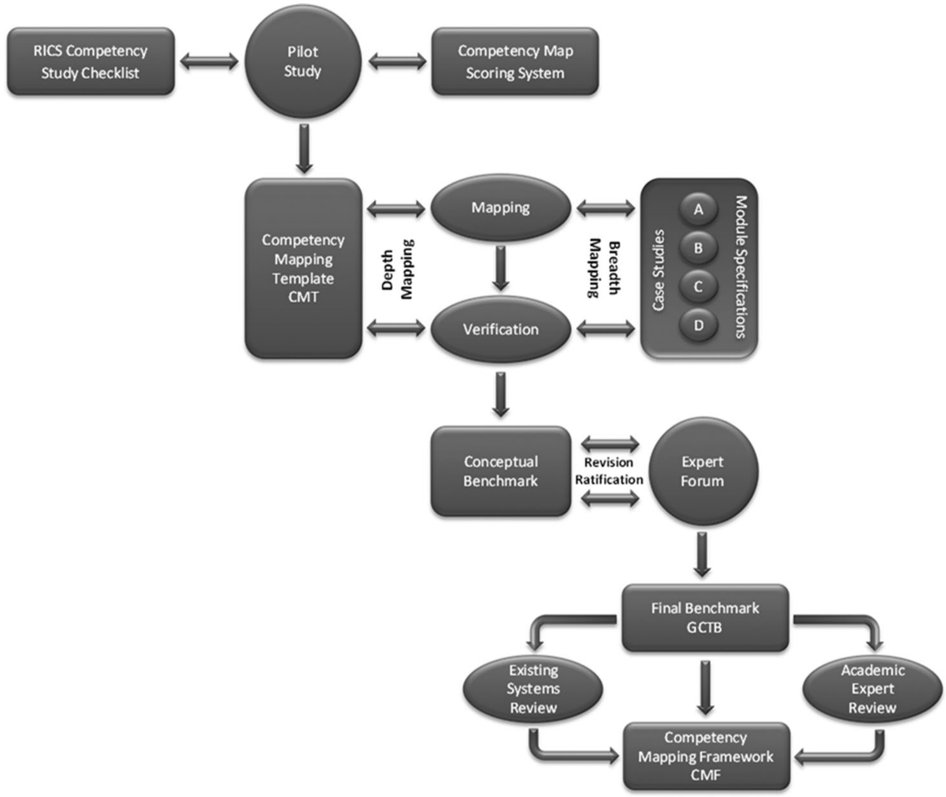


Figure 1. Research method chart.

The four stages and the main research instrument adopted in this research are detailed as follows.

### 4.1. *Stage 1: pilot study*

A literature review was conducted to identify the full QS study checklist structured by RICS competencies. This was followed by developing a competency mapping scoring system that could provide a numerical scale mapping of competencies to degree programme curricula (Figure 1). A pilot study involving two senior academic staff and two industry experts was used to test the scoring system and develop the final competency mapping template (CMT) (Figure 1). The CMT is a dual vector scale matrix with a 'breadth scale and a depth scale'. The breadth scale contains study topics, while the depth scale contains competencies. Therefore, the CMT formed the basis for carrying out case studies mapping competencies to existing degree programmes.

### 4.2. *Stage 2: case studies*

The selected four case studies (A, B, C and D) were leading QS honours degree programmes in the UK all accredited by the RICS (Figure 1). The case studies, therefore, provided the basis for the development of the benchmark for graduate competencies.

These include examination of four RICS accredited QS degree programmes. The CMT developed in stage 1 provides the template to map curricula to RICS competencies. The curricula of these programmes (module specifications) were mapped against RICS QS competencies at a detailed level using coverage (as a breadth scale) and amount of time spent in learning, that is, module credits (as a depth scale). The ensuing mapping was then verified for accuracy and consistency with the programme directors responsible for their delivery. Furthermore, descriptive statistical analysis was used to develop a conceptual competency benchmark using these four case studies, which is the final output of this stage.

### 4.3. *Stage 3: expert forum*

An expert forum comprising 15 persons (12 industry experts and 3 academic experts) was constituted to revise and modify the conceptual competency benchmark developed in stage 2 of the research above. The identified industry experts come from large, Small and Medium-sized Enterprises (SME) and micro-level organisations. These included QS employer organisations from both traditional consulting and contracting sectors. A total of 15 interviews were conducted comprising 3 academics (programme leaders), 6 consultant quantity surveyors (2 experts from each category of large, SME and micro) and 6 contractor quantity surveyors (2 experts from large, 3 from SME and 1 from micro-level organisation) (see Table 4 for details). The resulting findings were analysed using relevant descriptive statistics and presented as a ratified benchmark. Delphi technique (Rowe and Wright 2001) was used to extract and harmonise the views of the experts and to finalise the benchmark level of achievement of competencies for graduate QS.

### 4.4. *Stage 4: review of existing processes to integrate CMF*

The GCTB forms the basis of the final stage of the research, where it is incorporated into the existing programme curricular development and management process, creating the CMF. A detailed review of the existing programme validation and management methods was carried out. Three highly experienced RICS accredited QS honours degree programme directors (who are also full members of the RICS) were selected to develop the mechanism to integrate the GCTB and create the final CMF. This stage provides insight on how the CMF can be used within these existing systems to ensure academic quality standards.

## 5. RICS QS competencies

The RICS QS competencies provide the basis on which the competence of a chartered quantity surveyor is defined. These are arranged into three groups, depending upon their perceived relevance to the role of the quantity surveyor as follows:

(1) Mandatory competencies: personal, interpersonal and professional practice and business skills common to all pathways (into membership) compulsory for all candidates.
(2) Core competencies: primary skills of the candidate's chosen RICS pathway.
(3) Optional competencies: selected as an additional skill requirement for the candidate's chosen RICS pathway from a list of competencies relevant to that

pathway. In most cases there is an element of choice, though usually driven by their employer's specialism.

Similarly, the RICS distinguishes between three possible levels of attainment in each of a range of competences when setting its requirements for those seeking full membership as follows:

- Level 1: Knowledge (theoretical knowledge).
- Level 2: Knowledge and practical experience (putting it into practice).
- Level 3: Knowledge, practical experience and capacity to advise (explaining and advising).

There are 8 mandatory competencies, 7 core competencies and 10 optional competencies. The RICS stipulates that an APC candidate needs to achieve all mandatory competencies at Level 2 or above, and all core competencies at Level 3 (except the one not relevant to their specialisation, consulting or contracting as the case may be, which must be at Level 2). The further requirement is for 2 optional competencies at Level 2 or above.

## 6. The competency mapping scoring system

The competency mapping scoring system is developed as a dual vector scale matrix consisting of a 'breadth scale and a depth scale'. The breadth scale indicates the extent of coverage of competencies as mapped to the RICS QS study checklist (RICS 2008b). The check list provides 359 individual study topics categorised into 25 different competencies. These signify the extent of coverage (breadth of knowledge) expected under the current set of competencies. The depth scale provides an indication of the time spent on achieving competencies. These are briefly discussed as follows:

### 6.1. *Breadth scale*

RICS QS competencies were analysed at a detailed level using the QS study checklist (RICS 2008b). This checklist is used as the framework for developing the conceptual benchmark where the binary alternatives 1 and 0 are used to indicate coverage of a topic under a competency. For example,

- 1 – Reflects that the topic is dealt with by the degree programme concerned.
- 0 – Reflects that it is not dealt with by the degree programme concerned.

These are indicated against the three-level classification of level of achievement by the RICS (RICS 2009), as follows:

- Level 1 – Knowledge and understanding.
- Level 2 – Application of knowledge and understanding.
- Level 3 – Reasoned advice and depth of technical knowledge.

A specific topic may be covered at both Levels 1 and 2. In this case, there is a value 1 in both Level 1 and Level 2 columns. If a topic achieves Level 2 coverage, then it is assumed that there is always Level 1 coverage as well. In another topic, if the topic is dealt with at Level 1 only, then values 1 and 0 were placed against Level 1 and Level 2 columns, respectively. Level 3 achievements are not expected to be covered in degree programmes as it is not practical to expect a graduate to cover a competency at Level 3. However, as the benchmark reflects a minimum conceptual achievement level, it will not prevent anyone achieving a competency at Level 3 if it is feasible within his or her degree programme.

### 6.2. *Depth scale*

This reflects the amount of time spent on achieving a competency. In degree programmes, time spent on achieving module outcome is measured by 'credits' where every 10 hours spent is considered as 1 credit. A typical 20 credit-point module, therefore, reflects 200 hours of learning by the student. This constitutes direct contact with formal teaching, lectures, seminars, tutorials and such like, together with students' expected study time on the module content (time spent by students on their own in learning the topic concerned). The depth scale is only indicated at the competency level and not at the topic level as it is impractical to stipulate an expected number of study hours at a detailed level. Percentage scores are used to indicate the amount of time spent on each competency. These provide valuable information on the relative time spent for each competency. The depth scale represents the total time expected to be spent on learning a competency at the undergraduate level.

### 6.3. *CMT and competency mapping record*

A CMT incorporating the breadth and depth scales was developed on a spreadsheet using the competency mapping scoring system. It contains two tabs, one each for the breadth scale (mapping) and the depth scale (mapping). The breadth mapping tab contains the study checklist topics organised into competencies (vertical) mapped against module specifications (horizontal). In a similar way, the depth mapping tab contains the RICS QS competency list (vertical) mapped against module specifications (horizontal).

The mapping process involves taking each module specification, identifying module topics and mapping them against the breadth scale. Subsequently, the time utilised for each topic for a competency is estimated and noted in the corresponding cell in the depth scale mapping tab. When all breadth and depth scale information is recorded for a degree programme, it becomes a record of how module content is mapped against RICS competencies. This is termed as the competency mapping record (CMR) for the programme.

## 7. Competency mapping of the case studies

### 7.1. *Developing the conceptual benchmark*

The conceptual benchmark was developed by mapping module specifications of four universities' (case studies of) RICS accredited QS honours degree programmes against the RICS study checklist (RICS 2008b) using the aforementioned CMT. The process used in mapping competencies for the case studies is summarised as follows:

(1) A request to conduct a case study of the selected QS degree programme was sent to the respective programme director explaining the process.

(2) The module specifications and the programme module structure were obtained from the respective case study (university).
(3) The CMT with the breadth and depth scales was used to map the RICS competencies to the module specifications.
(4) Programme module specifications were individually mapped to competencies using the CMT by the researchers. These processes consisted of the following:
   (i) Topics for each module were identified and mapped to those in the breadth scale of study checklist topics.
   (ii) Using the module credit allocation and proportionately distributing it to module content, the learning time allocation for each topic was estimated and allocated in the depth scale.
   (iii) The process continued iteratively until mapping of all modules was completed to the researchers' satisfaction.
   (iv) The completed mapping for a degree programme was termed a CMR (Figure 2).
(5) The completed competency mappings (CMRs) were then sent to the respective programme directors for further revision.
(6) Revisions were discussed and agreed with the programme directors to finalise the CMR of each programme.

Each RICS competency is made up of several topics (known as the study checklist). Breadth mapping, which is the scope of coverage, was carried out across Level 1 and Level 2. As noted above, Level 3 is not included because a QS graduate would not have attained this level upon graduation. Since the benchmark is a minimum threshold, it is not required to be considered. Depth mapping was carried out at the competency level, unlike breadth mapping which was carried out at a detailed study checklist level. Credits hours are used for the depth mapping. There are a total of 360 credits (3600 hours) of learning in a degree programme. Therefore, there will be less than 3600 hours available to map against RICS competencies. This is because a typical degree programme contains topics that are related to but not specifically identified within RICS competencies. For example, the subject areas of basic economics, mathematics and topics such as the background to the legal system are not directly related to RICS competencies.

Both breadth and depth mappings of the case studies (A, B, C and D) were initially carried out by the researchers using the respective programme specifications. The results were then sent out to the programme leaders of the degree programmes


Figure 2. Competency mapping process.

concerned for necessary adjustments and ratifications. Descriptive statistics such as mean and percentage scores were used to analyse and present the results of the case studies as a conceptual framework.

### 7.2. *Comparative analysis of case studies*

The four case study competency mappings were collated and statistically analysed to develop the conceptual benchmark for mapping graduate level QS competencies. A summary of the depth mapping of case studies is provided (Table 1).

There are many variations on how the programme curricula of individual case studies (universities) are mapped to competencies. Most variations are in the mapping of a few core competencies and of the optional competencies. This is somewhat expected as individual programmes have their own strengths and character. The average total mapping of competencies stands at 78%, indicating that 22% of the curricula in undergraduate programmes reflect knowledge content that does not directly map against competencies. These are often fundamental and basic knowledge components that are essentially required in order to be able to deliver knowledge that would assist in the achievement of competencies. A detailed analysis of the weightings for mandatory, core and optional competencies across the four case studies is presented in Figure 3.

As indicated in Figure 3, it is very clear that all universities have given overwhelming priority to core competencies. Two universities have given the second level of priority for either optional or mandatory competencies.

## 8. The conceptual benchmark for graduate route

The conceptual benchmark (Table 2) is a two-dimensional matrix reflecting overall average coverage and average depth of coverage of the four case studies. The conceptual benchmark values reflect the levels of achievement of competencies by graduates completing a degree from the four case study QS programmes. It reveals under Level 1 and Level 2 columns the topics covered in all the four RICS accredited degree programmes examined. A value of 1 against a particular topic implies that at least one of the case study degree programmes covers this. The credits hours' column, which is the average of the four case study values, indicates typical expected times (in hours) devoted to each competency, while the percentage column shows the relative time proportion. Only a brief extract of the conceptual benchmark is shown (as the table extends to several pages).

On the whole, the conceptual benchmark shows the average level of graduate competency achievement from four universities (case studies) of RICS accredited programmes. Thus, the conceptual benchmark indicates graduate attainment of RICS QS competencies. This provided a basis for further investigation of industry and academic views of the conceptual benchmark and their expectations. This is essential to harmonise diverse views and to generate a minimum graduate competency benchmark that satisfies the aspirations of all stakeholders. In order to provide a meaningful comparison of the priorities of the conceptual benchmark, the summary of the depth and breadth scales for competencies is provided.

Table 3 is derived from obtaining average figures from the four case studies completed. The depth scale was developed using mean time periods utilised for each competency. The breadth scale was developed by considering the frequency of engagement

Table 1. Results of the comparative analysis of competency mapping of case studies – depth mapping.

| | University | A | B | C | D | Average hours | Percentage | Standard deviation |
|---|---|---|---|---|---|---|---|---|
| | Level | | | | | | | |
| | Credits | 340 | 330 | 460 | 450 | | | |
| | Hours | 3400 | 3300 | 4600 | 4500 | | | |
| Code | Competency | ← | Hours | → | | | | |
| | *Mandatory competencies* | | | | | | | |
| M001 | Accounting principles and procedures | 5 | 0 | 5 | 5 | 3.75 | 0.1 | 2.50 |
| M002 | Business planning | 30 | 10 | 5 | 55 | 25 | 0.8 | 22.73 |
| M003 | Client care | 25 | 5 | 60 | 40 | 32.5 | 1.1 | 23.27 |
| M004 | Communication and negotiation | 89 | 165 | 185 | 155 | 148.5 | 4.8 | 41.58 |
| M005 | Conduct rules, ethics and professional practice | 20 | 30 | 55 | 10 | 28.75 | 0.9 | 19.31 |
| M007 | Data management | 85 | 65 | 90 | 120 | 90 | 2.9 | 22.73 |
| M008 | Health and safety | 30 | 50 | 40 | 195 | 78.75 | 2.6 | 77.93 |
| M010 | Teamworking | 132 | 95 | 130 | 240 | 149.25 | 4.8 | 62.84 |
| | *Core competencies* | | | | | | | |
| T010 | Commercial management of construction | 50 | 105 | 120 | 10 | 71.25 | 2.3 | 50.72 |
| T017 | Contract practice | 373 | 190 | 240 | 90 | 223.25 | 7.2 | 117.71 |
| T013 | Construction technology and environmental services | 377 | 597 | 655 | 1090 | 679.75 | 22.0 | 298.56 |
| T022 | Design economics and cost planning | 230 | 280 | 230 | 270 | 252.5 | 8.2 | 26.30 |
| T062 | Procurement and tendering | 216 | 253 | 130 | 130 | 182.25 | 5.9 | 62.20 |
| T067 | Project financial control and reporting | 65 | 55 | 63 | 55 | 59.5 | 1.9 | 5.26 |
| T074 | Quantification and costing of construction works | 380 | 520 | 430 | 390 | 430 | 13.9 | 63.77 |
| | *Optional competencies* | | | | | | | |
| T008 | Capital allowances | 2 | 0 | 20 | 20 | 10.5 | 0.3 | 11.00 |
| M006 | Conflict avoidance, management and dispute resolution procedures | 91 | 30 | 120 | 30 | 67.75 | 2.2 | 45.17 |
| T016 | Contract administration | 50 | 60 | 82 | 60 | 63 | 2.0 | 13.52 |
| T020 | Corporate recovery and insolvency | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| T025 | Due diligence | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| T045 | Insurance | 30 | 10 | 0 | 0 | 10 | 0.3 | 14.14 |

(*Continued*)

Table 1. (*Continued*)

| | University | A | B | C | D | Average hours | Percentage | Standard deviation |
|---|---|---|---|---|---|---|---|---|
| T063 | Programming and planning | 80 | 80 | 103 | 185 | 112 | 3.6 | 49.86 |
| TO66 | Project evaluation | 100 | 45 | 225 | 220 | 147.5 | 4.8 | 89.49 |
| T077 | Risk management | 60 | 15 | 110 | 20 | 51.25 | 1.7 | 44.04 |
| M009 | Sustainability | 100 | 150 | 265 | 150 | 166.25 | 5.4 | 69.93 |
| | Total hours | 2620 | 2810 | 3363 | 3540 | 3083.25 | 100.0 | 438.23 |
| | Percentage coverage of competencies | 77 | 85 | 73 | 79 | 78 | | 0.05 |

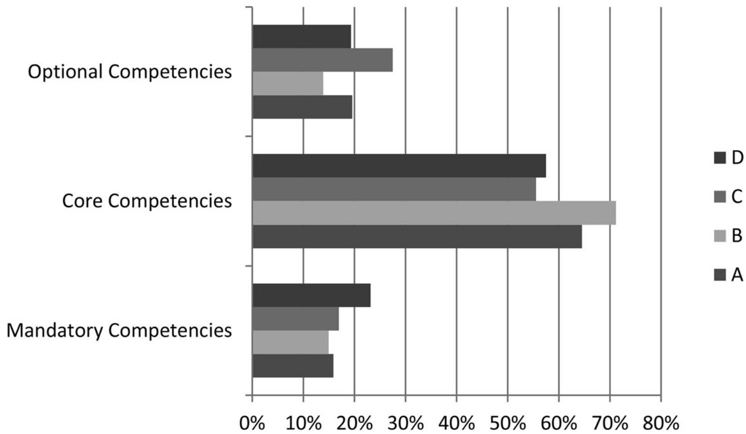


Figure 3. Cross-analysis of types of competencies for case studies A, B, C and D.

with the topics in the study checklist and considering any of the case study programmes dealing with the topic at least once (considered as 1 – contributing to the count). There are 290 topics used at Level 1 across the four case studies and 93 topics used at Level 2. This does not necessarily imply that any one case study (university) used all 290 topics identified here. The total of 290 and 93 for Levels 1 and 2, respectively, indicate the maximum number of topics dealt with across the four case studies. Similarly, there are a total of 3083 hours of learning representing 86% of learning time for a programme (Table 3).

A detailed analysis of the conceptual benchmark weighting of competencies – mandatory, core and optional competencies – is presented.

The core competencies have the greatest weighting with a 62% share, followed by optional competencies with 20% and mandatory competencies with an 18% share. The conceptual benchmark provides the basis for the development of the final benchmark for graduate level competencies. Therefore, the conceptual benchmark was presented to the expert forum (Figure 4).

## 9. Development of the final benchmark for graduate routes

The conceptual benchmark was presented to a selected expert forum for refinement of both breadth and depth scales for all study topics and competencies. Using the Delphi methodology, the views of experts were harmonised to create the final benchmark. The process is briefly explained as follows.

### 9.1. *Establishing the expert forum*

The forum of experts consisted of industry practitioners from large, SME and micro-level QS organisations. These included QS employer organisations from both the traditional consulting and contracting sectors. A minimum of two experts from each category were sought for this exercise. In addition, three QS programme directors from RICS accredited programmes were also invited to participate. All members were chartered surveyors and experienced either as practitioners or academics. The forum consisted of 15 members representing all types of QS employers and academics (Table 4).

Table 2. Results of the sample of conceptual benchmark.

| Competency | Level 1 | Level 2 | Level 3 | Credit hours | Percentage |
|---|---|---|---|---|---|
| *Mandatory competencies* | | | | | |
| Accounting principles and procedures (M001) – Level 1 | | | | 3.75 | 0.1 |
| Balance sheets/profit and loss account | 0 | 0 | | | |
| Taxation | 1 | 0 | | | |
| Revenue and capital expenditure | 0 | 0 | | | |
| Cash flows | 1 | 0 | | | |
| Profitability | 1 | 0 | | | |
| Insolvency | 0 | 0 | | | |
| Legislation | 1 | 0 | | | |
| Business planning (M002) – Level 1 | | | | 25 | 0.8 |
| Legislation | 1 | 0 | | | |
| Short-/long-term strategies | 1 | 0 | | | |
| Market analysis | 1 | 0 | | | |
| Five-year plans | 1 | 0 | | | |
| Business support services – administration, secretarial, HR, IT and so on | 1 | 0 | | | |
| Staffing levels – recruitment/turnover | 1 | 0 | | | |
| Continued … | | | | | |
| *Core competencies* | | | | | |
| Commercial management of construction (T010) – Level 3 | | | | 71.25 | 2.3 |
| Estimating | 1 | 1 | | | |
| Establishing budgets | 1 | 1 | | | |
| Cash flows | 1 | 1 | | | |
| Reporting financial progress against budget | 1 | 1 | | | |
| Procurement of subcontracts | 1 | 0 | | | |
| Financial management of supply chain | 1 | 0 | | | |
| Financial management of multiple projects | 1 | 0 | | | |
| Contract practice (T017) – Level 3 | | | | 223.25 | 7.2 |
| Principles of contract law | 1 | 0 | | | |
| Legislation | 1 | 0 | | | |
| Current case-law – lookout for cases reported in journals | 1 | 0 | | | |
| Standard forms of main and subcontract – for example, JCT, NEC/ECC, GC Works, ICE, ACA, IChemE, FIDIC and so on | 1 | 1 | | | |
| Final accounts | 1 | 1 | | | |
| Completion | 1 | 0 | | | |
| Liquidated and ascertained damages | 1 | 0 | | | |
| Defects rectification period | 1 | 1 | | | |
| Construction technology and environmental services (T013) – Level 3 | | | | 679.75 | 22.0 |
| Construction technology | 1 | 0 | | | |
| Substructures – basements, types of piling and so on | 1 | 0 | | | |
| Superstructures | 1 | 0 | | | |

(*Continued*)

Table 2. (*Continued*)

| Competency | Level 1 | Level 2 | Level 3 | Credit hours | Percentage |
|---|---|---|---|---|---|
| Comparison of concrete/steel frames | 1 | 0 | | | |
| External walls, windows and doors | 1 | 0 | | | |
| Cladding/glazing | 1 | 0 | | | |
| Planning legislation and procedures | 0 | 0 | | | |
| Party wall issues/rights of light | 0 | 0 | | | |
| Dangerous/banned substances – asbestos and so on | 0 | 0 | | | |
| Prefabrication | 1 | 0 | | | |
| Disability legislation | 1 | 0 | | | |
| Design economics and cost planning (T022) – Level 3 | | | | 252.5 | 8.2 |
| Economics of design – site density, wall/floor ratio, storey heights, room sizes, letable/non-letable | 1 | 1 | | | |
| Sources of cost data – BCIS/in-house database/other external sources | 1 | 1 | | | |
| Inflation (tender/construction) | 1 | 1 | | | |
| Location factors, regional variations | 1 | 1 | | | |
| Currency fluctuations | 1 | 0 | | | |
| Estimating | 1 | 1 | | | |
| Cost Plans | 1 | 1 | | | |
| Cost Planning | 1 | 1 | | | |
| Life cycle costing – capital/running costs/replacement | 1 | 1 | | | |
| Value engineering | 1 | 1 | | | |
| Value management | 1 | 1 | | | |
| Continued … | | | | | |
| *Optional competencies* | | | | | |
| Capital allowances (T008) | | | | 10.5 | 0.3 |
| Current legislation | 1 | 0 | | | |
| Capital and revenue expenditure | 1 | 0 | | | |
| Taxation | 1 | 0 | | | |
| Capital allowances legislation | 1 | 0 | | | |
| Claiming capital allowances | 1 | 0 | | | |
| Plant and machinery | 1 | 0 | | | |
| Enhanced capital allowances | 0 | 0 | | | |
| Conflict avoidance, management and dispute resolution procedures (M006) | | | | 67.75 | 2.2 |
| How standard forms of contract deal with conflict avoidance and dispute resolution | 1 | 0 | | | |
| Conflict avoidance | 1 | 0 | | | |
| Partnering | 1 | 0 | | | |
| Negotiation | 1 | 0 | | | |
| Mediation | 1 | 0 | | | |
| Conciliation | 1 | 0 | | | |
| Adjudication | 1 | 0 | | | |
| Arbitration | 1 | 0 | | | |
| Expert witness | 1 | 0 | | | |
| Continued … | | | | | |
| | 298 | 99 | | 3083.25 | 100.0 |

Note: Building Cost Information Service, BCIS.

Table 3. Results of the summary of conceptual benchmark.

| Code | Competency | Depth scale: Learning hours – Average | Depth scale: Learning hours – Time % | Breadth scale: % coverage of topics – Level 1 | Breadth scale: % coverage of topics – Level 2 |
|---|---|---|---|---|---|
| | *Mandatory competencies* | | | | |
| M001 | Accounting principles and procedures | 3.75 | 0.1 | 80.0 | 0.0 |
| M002 | Business planning | 25 | 0.8 | 100.0 | 0.0 |
| M003 | Client care | 32.5 | 1.1 | 75.0 | 50.0 |
| M004 | Communication and negotiation | 148.5 | 4.8 | 100.0 | 87.5 |
| M005 | Conduct rules, ethics and professional practice | 28.75 | 0.9 | 64.3 | 14.3 |
| M007 | Data management | 90 | 2.9 | 100.0 | 71.4 |
| M008 | Health and safety | 78.75 | 2.6 | 100.0 | 0.0 |
| M010 | Teamworking | 149.25 | 4.8 | 100.0 | 75.0 |
| | *Core competencies* | | | | |
| T010 | Commercial management of construction | 71.25 | 2.3 | 100.0 | 55.6 |
| T017 | Contract practice | 223.25 | 7.2 | 100.0 | 42.9 |
| T013 | Construction technology and environmental services | 679.75 | 22.0 | 85.7 | 0.0 |
| T022 | Design economics and cost planning | 252.5 | 8.2 | 100.0 | 73.3 |
| T062 | Procurement and tendering | 182.25 | 5.9 | 92.3 | 15.4 |
| T067 | Project financial control and reporting | 59.5 | 1.9 | 100.0 | 30.0 |
| T074 | Quantification and costing of construction works | 430 | 13.9 | 95.2 | 38.1 |
| | *Optional competencies* | | | | |
| T008 | Capital allowances | 10.5 | 0.3 | 58.3 | 0.0 |
| M006 | Conflict avoidance, management and dispute resolution procedures | 67.75 | 2.2 | 100.0 | 0.0 |
| T016 | Contract administration | 63 | 2.0 | 95.5 | 9.1 |
| T020 | Corporate recovery and insolvency | 0 | 0.0 | 15.4 | 0.0 |
| T025 | Due diligence | 0 | 0.0 | 20.0 | 0.0 |
| T045 | Insurance | 10 | 0.3 | 50.0 | 0.0 |
| T063 | Programming and planning | 112 | 3.6 | 100.0 | 50.0 |
| TO66 | Project evaluation | 147.5 | 4.8 | 100.0 | 76.9 |
| T077 | Risk management | 51.25 | 1.7 | 84.6 | 53.8 |
| M009 | Sustainability | 166.25 | 5.4 | 100.0 | 8.3 |
| | Total | 3083.25 hours | 100.0 | 290 topics | 93 topics |

## 9.2. *Revision and ratification of the conceptual benchmark*

The stages followed in the expert forum were as follows:

(1) Invitations to industry and academic experts to join the expert forum.
(2) Appointment of the expert forum members.
(3) Arranging and conducting individual expert forum interviews to obtain views on revisions to the conceptual benchmark.

Table 4. Composition of the expert forum.

| No. | Type of organisation | Abbreviation | Size | Code |
|---|---|---|---|---|
| 1 | Consulting practice | PQS | Large | L |
| 2 | Consulting practice | PQS | Large | D |
| 3 | Consulting practice | PQS | SME | G |
| 4 | Consulting practice | PQS | SME | E |
| 5 | Consulting practice | PQS | Micro | F |
| 6 | Consulting practice | PQS | Micro | B |
| 7 | Contracting | CQS | Large | Q |
| 8 | Contracting | CQS | Large | K |
| 9 | Contracting | CQS | SME | A |
| 10 | Contracting | CQS | SME | J |
| 11 | Contracting | CQS | Micro | C |
| 12 | Contracting | CQS | SME | H |
| 13 | Academia | Academic | University | N |
| 14 | Academia | Academic | University | M |
| 15 | Academia | Academic | University | P |

(4) Collating the views of the expert forum members and developing the revised benchmark considering the average views of all experts.
(5) Distributing the revised benchmark to all experts to obtain views on further revisions or concurrence with the revised benchmark.
(6) Collating all further revisions to develop the ratified benchmark.
(7) Converting the ratified benchmark to the final benchmark; this comprises the GCTB.

The details of how the revised benchmark values were developed from the conceptual benchmark and the development of the ratified benchmark values from the revised benchmark are explained as follows.

For the breadth scale, mode was used to analyse expert forum views. A competency consists of several topics. At Level 1, a topic under a certain competency would either be expected (i.e. by the experts) to be covered (i.e. marked as 1) or not expected to be covered (i.e. marked as 0), in graduate QS education. The same rules applied to Level 2

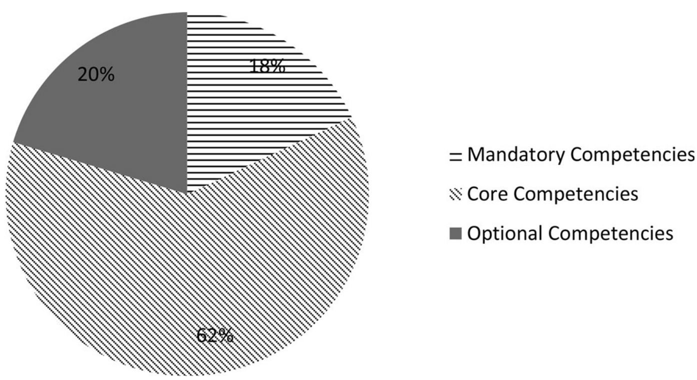


Figure 4. Conceptual benchmark – weighting of competencies.

coverage. Level 3 was not considered because it is not a typical level of attainment in graduate QS education.

The modes of the 15 experts' views were then derived for each topic at both Level 1 and Level 2. For example, if 8 experts (hence 8 ticks) or more thought that a topic should be covered in graduate QS education at Level 1, the topic was marked as 1 under Level 1, and vice versa. The same applied to Level 2 coverage. The numbers of topics covered under each competency, marked as 1, were then used to calculate the percentage coverage of topics for that competency, at both Level 1 and Level 2.

The average views of all experts were used for the depth scale. The experts were asked to amend the conceptual benchmark values, that is, credit hours to reflect the learning hours they thought should be allocated to each competency in graduate QS education. The mean value of the 15 expert forum views on credit hours was then computed for each competency. The mean figure was converted to percentage score to illustrate the relative time proportion for each competency.

The Delphi technique was utilised to extract and harmonise the views of the experts. This enabled the researchers to achieve a consensus view from the forum to finalise the benchmark minimum levels of achievement of competencies for graduate quantity surveyors. A comparison of the conceptual, revised and ratified benchmarks using the depth scale is presented in Figure 5.

### 9.3. *The GCTB – final benchmark*

The final ratified benchmark with the dual scale breadth and depth mappings was converted to create the final GCTB. Therefore, GCTB represents minimum levels of competency achievement. A summarised version of the final benchmark (GCTB) is presented.

As shown in Table 5 analysing the breadth scale, it is clear that there are a total of 305 topics to be covered representing 85% of the total topics at Level 1. As one would expect, this falls to 102 topics (28%) at Level 2. Also, the depth scale is expressed in hours rather than in credits to enable each competency to be distributed and mapped against multiple modules (if required). The percentage time allocation clearly indicates the relative importance of competencies in terms of learning hours that need to be spent at the undergraduate level. The overall levels of coverage of topics for mandatory, core and optional competencies are summarised in Figure 6.

As indicated in Figure 6 it is evident that most topics, especially within mandatory and core competencies, need to be covered at Level 1. There is a slightly higher coverage expected at Level 2 for mandatory competencies over core competencies.

The depth scale indicates the minimum number of learning hours that needs to be allocated to each competency in a RICS accredited QS honours degree programme. The module specifications of such a programme can be mapped to the RICS QS competencies, identifying the learning hours spent for each competency. The minimum benchmark developed in this research provides a threshold minimum to achieve in this competency. This is presented in Figure 7.

Similarly, the breadth scale in the benchmark indicates the expected percentage coverage of the RICS QS study checklist. Thus, a summary of which study topics need to be covered is indicated in the benchmark presented in Figure 8.

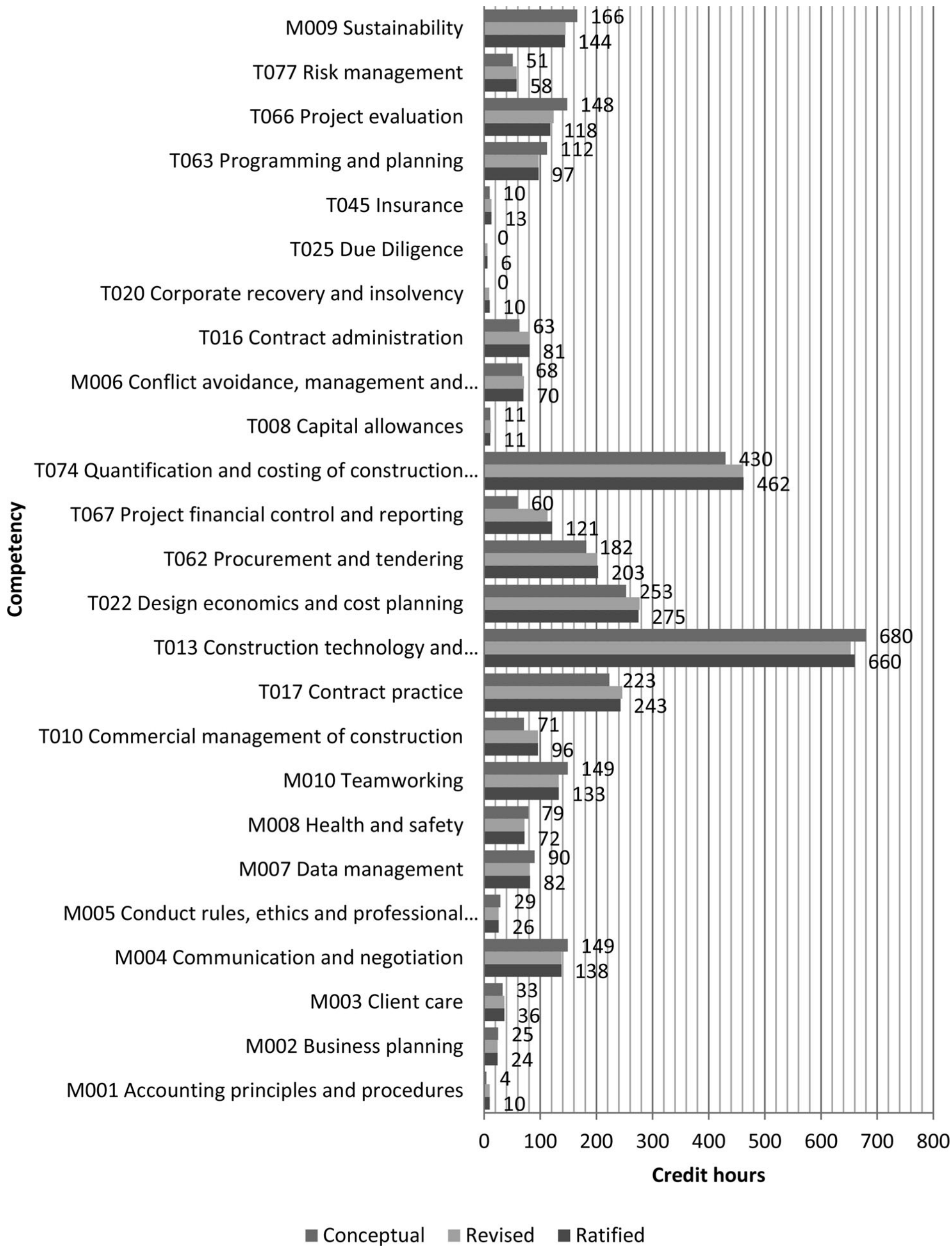


Figure 5. Cross-comparison of ratified, revised and conceptual benchmarks for graduate competencies.

## 10. Discussion

It is increasingly evident today that significant attention is paid to competency-based education for professionally oriented degree programmes in HEIs in many disciplines across the globe. The purpose of this research was to develop a CMF for the professionally oriented degree programmes taking QS honours degree programme as an

Table 5. Summarised final benchmark (GCTB).

| GCTB | | Depth scale | | Breadth scale | |
|---|---|---|---|---|---|
| | | Learning hours | | % coverage of topics | |
| Code | Competency | Ratified | Time % | Level 1 | Level 2 |
| C1 | *Mandatory competencies* | | | | |
| C1.1 | M001 Accounting principles and procedures | 10 | 0.3 | 80 | 0 |
| C1.2 | M002 Business planning | 24 | 0.8 | 100 | 0 |
| C1.3 | M003 Client care | 36 | 1.1 | 75 | 50 |
| C1.4 | M004 Communication and negotiation | 138 | 4.3 | 100 | 88 |
| C1.5 | M005 Conduct rules, ethics and professional practice | 26 | 0.8 | 64 | 14 |
| C1.6 | M007 Data management | 82 | 2.6 | 100 | 71 |
| C1.7 | M008 Health and safety | 72 | 2.3 | 100 | 0 |
| C1.8 | M010 Teamworking | 133 | 4.2 | 100 | 75 |
| C2 | *Core Competencies* | | | | |
| C2.1 | T010 Commercial management of construction | 96 | 3.0 | 100 | 56 |
| C2.2 | T017 Contract practice | 243 | 7.6 | 100 | 43 |
| C2.3 | T013 Construction technology and environmental services | 660 | 20.7 | 86 | 0 |
| C2.4 | T022 Design economics and cost planning | 275 | 8.6 | 100 | 73 |
| C2.5 | T062 Procurement and tendering | 203 | 6.4 | 92 | 15 |
| C2.6 | T067 Project financial control and reporting | 121 | 3.8 | 100 | 30 |
| C2.7 | T074 Quantification and costing of construction works | 462 | 14.5 | 95 | 38 |
| C3 *Optional Competencies* | | | | | |
| C3.1 | T008 Capital allowances | 11 | 0.3 | 58 | 0 |
| C3.2 | M006 Conflict avoidance, management and dispute resolution procedures | 70 | 2.2 | 100 | 0 |
| C3.3 | T016 Contract administration | 81 | 2.5 | 96 | 9 |
| C3.4 | T020 Corporate recovery and insolvency | 10 | 0.3 | 15 | 0 |
| C3.5 | T025 Due diligence | 6 | 0.2 | 20 | 0 |
| C3.6 | T045 Insurance | 13 | 0.4 | 50 | 0 |
| C3.7 | T063 Programming and planning | 97 | 3.0 | 100 | 50 |
| C3.8 | T066 Project evaluation | 118 | 3.7 | 100 | 77 |
| C3.9 | T077 Risk management | 58 | 1.8 | 85 | 54 |
| C3.10 | M009 Sustainability | 144 | 4.5 | 100 | 8 |
| | Total | 3188 hours | 100.0 | 305 topics | 102 topics |

exemplary. This was achieved by conducting an extensive review of relevant literature, a pilot study, case studies (including semi-structured interviews) and an expert forum using the Delphi technique in developing the CMF. The selected case studies comprised four leading QS honours degree programmes in the UK, all accredited by the RICS. The curricula of these programmes (module specifications) were mapped

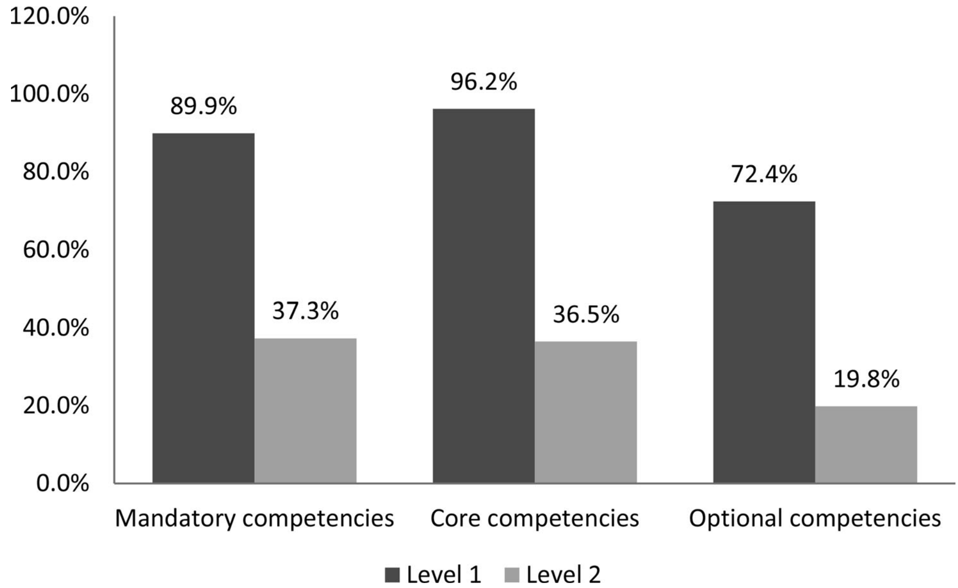


Figure 6. Overall comparison of coverage of topics (breadth scale) across competency categories.

against RICS QS competencies. The case studies, consequently, provided the basis for the development of the benchmark for graduate competencies. The 25 RICS competencies identified in this research are grouped into three as follows: (1) 8 mandatory competencies, (2) 7 core competencies and (3) 10 optional competencies (RICS 2009). This approach is similar to that of previous studies. For instance, Ahn, Annie, and Kwon (2012) identified 14 key competencies for the US construction graduates. Through factor analysis the authors grouped the identified competencies into four classes of competencies for construction graduates as follows: (1) general competency, (2) affective competency, (3) cognitive competency and (4) technical competency.

Arain (2010) identified the graduate competencies for baccalaureate level construction education in Alberta, Canada. The author recommended that the breadth and depth of the core curricula ensured sufficient coverage of fundamental and extended topics in construction project management. This present research mirrors similar research undertaken in Alberta, Canada (see Arain 2010), the USA (see Ahn, Annie, and Kwon 2012), Australia (see Newton and Goldsmith 2011a, 2011b; Newton et al. 2012), the UK (see Perera and Pearson 2011), Germany (see Schaeper 2009) and South Africa (see Nkado and Meyer 2001), but expands the works with increased attention to the mapping of the competencies to the depth and breadth scales. Perlin (2011) recognised mapping as an approach for the 'evaluation and restructuring of an individual course and curriculum objectives for alignment with programme competencies and accreditation requirements'. The mapping process further provides an opportunity for evaluating how well the overall curriculum reflects the programme's stated competencies in terms of breadth and depth (Rissi and Gelmon 2014). Against this backdrop, this research

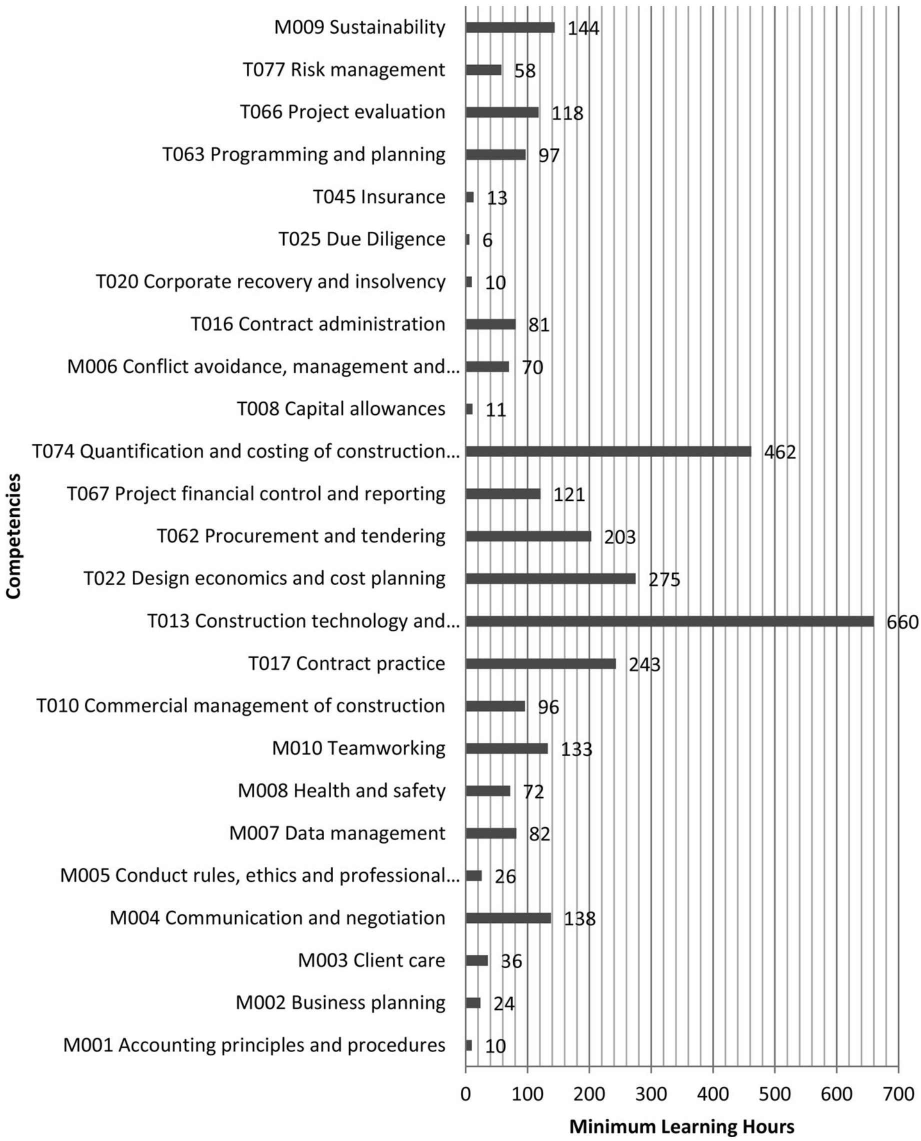


Figure 7. Benchmark minimum learning hours – depth scale.

developed a CMF for programme appraisal and benchmarking. The CMF consists of three essential instruments to include GCTB, CMT and CMR. In achieving the CMF, a logical learning credit-based competency mapping scoring system was developed as a dual scale matrix consisting of a ‘breadth scale’ and ‘a depth scale’. The breadth scale consists of four columns to include Level 1 and Level 2 columns that indicate the level at which a topic is to be achieved at the undergraduate level. The other two columns present statistics of percentage coverage of topics at Level 1 and Level 2, respectively. The depth scale consists of two columns to include, firstly, the credit hours and indicates the amount of time an

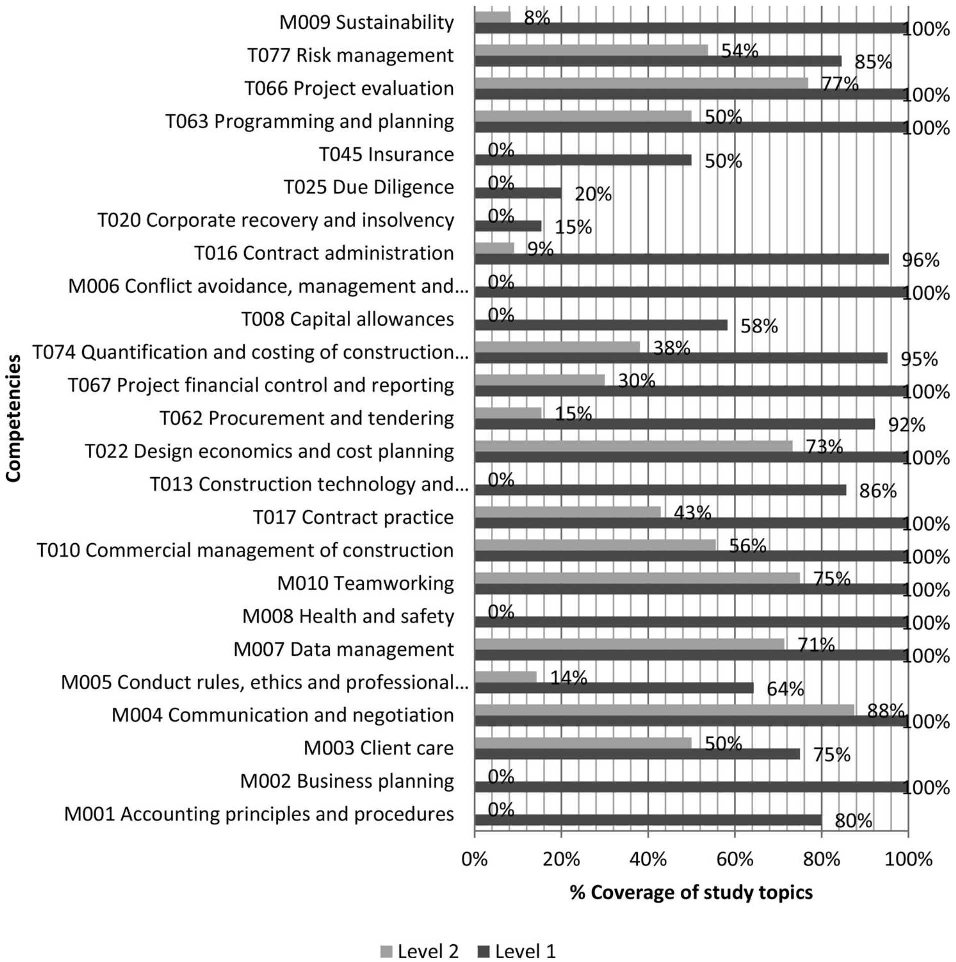


Figure 8. Benchmark minimum coverage of study topics – breadth scale.

undergraduate student should spend in learning topics related to a competency, and secondly, statistics of the percentage time allocated for a competency (see Figure 9 for details). This approach is similar to the spreadsheet analysis adopted by Newton and Goldsmith (2011a) when developing TLOs to benchmark the graduate outcomes from a Bachelor-level study in building and construction management in Australia.

Therefore, the mapping process involves taking each module specification, identifying module topics and mapping them against the breadth scale. Subsequently, the time utilised for each topic within a competency is estimated and noted in the depth scale. When all breadth and depth scale information is recorded for a degree programme, it becomes a record of how module content is mapped against competencies. As it is revealed in this research, CMF provides a minimum threshold benchmark level of competency required in undergraduate studies in QS in the UK. The module contents were mapped to competencies using the competency map scoring system incorporating the depth and breadth scales.

| Graduate Competency Threshold Benchmark (GCTB) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Breadth Scale | | | | Depth Scale | |
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percent age |
| **Code** | **RICS QS Study Check list Topics** | **305** | **102** | **85%** | **28%** | **3188** | **100.0%** |
| C1.8.7 | Supply chain management | 1 | 1 | | | | |
| C1.8.8 | Legislation on selecting project teams | 1 | 0 | | | | |
| C2 | CORE COMPETENCIES | 136 | 43 | 94.4% | 29.9% | 2060 | 65% |
| **C2.1** | **Commercial management of construction (T010) – Level 3** | 9 | 5 | 100.0% | 55.6% | 96 | 3.0% |
| C2.1.1 | Estimating | 1 | 1 | | | | |
| C2.1.2 | Establishing budgets | 1 | 1 | | | | |
| C2.1.3 | Cash flows | 1 | 1 | | | | |
| C2.1.4 | Reporting financial progress against budget | 1 | 1 | | | | |
| C2.1.5 | Procurement of labour | 1 | 0 | | | | |
| C2.1.6 | Procurement of plant and materials | 1 | 0 | | | | |
| C2.1.7 | Procurement of sub-contracts | 1 | 1 | | | | |
| C2.1.8 | Financial management of supply chain | 1 | 0 | | | | |
| C2.1.9 | Financial management of multiple projects | 1 | 0 | | | | |
| **C2.2** | **Contract practice (T017) – Level 3** | 28 | 12 | 100.0% | 42.9% | 243 | 7.6% |
| C2.2.1 | Principles of contract law | 1 | 0 | | | | |
| C2.2.2 | Legislation | 1 | 0 | | | | |
| C2.2.3 | Current case-law – look out for cases reported in journals | 1 | 0 | | | | |
| | Standard forms of main and sub contract – e.g. JCT, NEC/ECC, GC Works, ICE, ACA, | | | | | | |

Figure 9. Sample portion of final GCTB.

## 11. Conclusions

This research seeks to usefully improve the relationship between that which is taught in HEIs and that which is sought by the industry, to align practice and academic priorities. Against this backdrop, this research developed a CMF for programme appraisal and benchmarking. The CMF consists of three essential instruments to include a GCTB, a CMT and a CMR. These research findings revealed that having analysed the breadth scale, it is clear that there is a total of 305 topics to be covered representing 85% of all topics at Level 1. This figure falls to 102 topics (28%) at Level 2. It is evident that most topics, especially for mandatory and core competencies, need to be covered at Level 1. Furthermore, there is a slightly higher coverage expected at Level 2 for mandatory competencies over core competencies. The depth scale is expressed in hours rather than in credits to enable each competency to be distributed and mapped against multiple modules. Analysing the depth scale, it indicates that there is a total of 3188 hours of learning time expected on RICS QS competencies. It is obvious that CMF developed in this research have both theoretical and practical implications. The theoretical implication provides a useful methodology to map programme curricula to competencies, which can be replicated in any construction-oriented degree programme. The practical implication indicates that CMF can be used effectively in programmes development and validation. The CMF would further be useful in monitoring and improving quality and professional standards of any degree programmes. It is believed that this research finding would align practice and academic priorities, thus enhancing the employability of construction graduates.

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**Disclosure statement**

No potential conflict of interest was reported by the authors.

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# Chapter 27
# Mapping Sustainability in the Quantity Surveying Curriculum: Educating Tomorrow's Design Economists

Chika Udeaja, Damilola Ekundayo, Lei Zhou,
John Pearson and Srinath Perera

## 27.1 Introduction

The climate change debate has generated considerable interest in the sustainable development agenda throughout the world. The UK, like most other nations, is becoming increasingly aware of the significance and value of having a sustainable environment policy (Khalfan, 2006). In the built environment, the challenges are massive, given the size of the construction industry which accounts for 8% of the UK's gross domestic product; consumes an enormous amount of resources with a major impact on the manufacturing industry that creates products for construction projects and society at large. The built environment's contribution to the economic well-being of a country, the social well-being of people, and the impact on the environment is hugely significant (Cowling *et al.*, 2007; BERR, 2008). Theron (2010) estimated that the built environment in its widest sense is responsible for 40% of $CO_2$ emission, as well as 40% of all energy used. The Kyoto Protocol, EU Emission Scheme, recent changes in building regulations, and Climate Change legislation are a growing recognition of the need to minimise the consequences of human activities on the environment. These initiatives have created the need for a major reform in the UK construction industry with significant implications for the educational systems.

The green agenda and construction education are intricately linked (see e.g. Walton and Galea, 2005; Cotgrave and Alkhaddar, 2006; Hayles and Holdsworth, 2008; Theron, 2010; Ekundayo *et al.*, 2011). The rationale, therefore, for embedding green issues within the construction curriculum is a powerful imperative for change. This is mainly as a result of policy drivers and in some cases existing research but the response from the academic community is less clear. However, it is increasingly recognised that the curriculum should incorporate sustainability, in order to produce graduates that will confidently take care of the environment and not damage it for future users. Hayles and Holdsworth (2008) argued that the twenty-first

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century is seen as the time for UK universities to embrace new ways of working. This is especially important if the educational system is to continue to be competitive and also meet the needs of its ever demanding stakeholders. A major challenge for the universities is the ability to provide products, and to an extent services, that meet stakeholders needs and aspirations, especially in relation to the sustainability agenda.

This chapter addresses how sustainability is incorporated into the education curriculum, to address professional competencies in construction related programmes with specific reference to quantity surveying (QS). It proposes a strategy to support the development of desired competencies in sustainability.

There is a growing interest in the sustainability agenda and to identify the quality and quantity of sustainability-related materials within the QS curriculum. This chapter focuses on QS degree programmes to identify broad and specific changes needed to develop competencies relevant to QS practices. First, it attempts to map the sustainability activities within the QS programme. To achieve this, a review is undertaken to determine the main areas of interest in sustainable construction particularly in QS, design or construction economics. Primary data collected using case studies are used to qualitatively map the extent of sustainability-related features within the curriculum in the QS degree programmes. The findings are analysed to determine the extent of sustainability-related topics or areas within the curriculum.

## 27.2 Literature review on sustainability issues

The terms "sustainability", "sustainable development" and 'sustainable construction' are words that have become common currency in recent years. They are phrases that are interpreted in different ways but the underlying principle is one of doing things differently to safeguard the environment. Numerous definitions have been proposed but there is no universal agreement of what exactly sustainability is meant to be within the curriculum. This section will review the fundamental change of Sustainable Development in Higher Education and identify the challenges the QS programme will face if the sustainability agenda is not addressed in the curriculum.

### *Greening the curricula*

This section explores the views of some academics on sustainability-related education within the built environment curricula. There are a number of studies carried out to explore the opportunity to embed sustainability agenda into the built environment curricula (Perdan *et al*., 2000; Fenner *et al*., 2005; Cotgrave and Alkhadder, 2006; Murray *et al*., 2006; Cowling *et al*., 2007; Hayles and Holdsworth, 2008; Sayce *et al*., 2009; Iyer-Raniga *et al*., 2010). These studies have been carried out to encourage staff to make commitment to sustainability by making changes to their modules or provide new modules for student learning. As early as 2000, Perdan *et al*. attempted to adopt a multidisciplinary approach to teaching sustainability for engineering students at the University of Surrey and they developed IT-based learning materials and case studies to facilitate understanding of concepts of sustainability and how solutions could be developed. Fenner *et al*. (2005)

reviewed the education for sustainable development in the Department of Engineering at the University of Cambridge and encouraged students' self-reflective learning processes to obtain solutions for the challenges of sustainable development.

Cotgrave and Alkhaddar (2006) reviewed the undergraduates' construction management curricula at Liverpool John Moores University and established that sustainable design and technology was superficial during the final year. Murray *et al*. (2006) implemented a full curriculum review to identify the gap in provision of sustainable construction education at Plymouth University. The study found that although discipline-specific environmental aspects were included in the curriculum, few generic aspects of sustainability such as citizenship or poverty were also covered.

Cowling *et al*. (2007) argued that education for sustainable development has become increasingly significant within the built environment curriculum at Kingston University. They explored students' familiarity, understanding and interest in sustainable development and how these developed over their time at the university. The university's emphasis on sustainable development provided an opportunity to contribute greatly to the students' awareness of the subject given that they are enrolled on courses with interest but often with a low knowledge base. Hayles and Holdsworth (2008) conducted an action research project at RMIT University, Australia to embed sustainability agenda into the core curriculum of the undergraduate programme at the School of Property, Construction and Project Management. The results showed how sustainability issues were embedded into three new modules. Iyer-Raniga *et al*. (2010) conducted research on construction management students at RMIT to compare sustainability activities between Melbourne and Singapore. The findings showed that there are no significant differences in the perceptions, knowledge and understanding of sustainability issues between the two sets of students.

While the list of previous research in the area of sustainability education is not exhaustive, it does indicate the wide range of challenges faced in incorporating sustainability-related education within the QS programme.

## Challenges facing the QS professional

Previous research provided some understanding of the meaning and significance of QS (Lee and Hogg, 2009; Perera *et al*., 2010; Simpson, 2010). The role of the quantity surveyor as suggested by the Royal Institution of Chartered Surveyors (RICS, 1971) cited in Nkado and Meyer (2001) is associated with measurement and valuation. They argued that quantity surveyors provide cost management services for construction projects in the context of forecasting, analysing, planning, controlling and accounting. Others suggested that competent quantity surveyors must have a range of skills and knowledge which can be applied in a range of projects and organisations. What is clear is that the roles of quantity surveyors have become extremely diversified, to match the changing needs of employers (Ashworth and Hogg, 2007). In the UK, a number of construction companies have rebranded themselves to respond to the needs of the sustainability agenda.

Achieving progress towards sustainability is critical to the future well-being of society which has long being recognised by the Higher Education Funding Council for England (HEFCE, 2010). They have placed sustainability as a major objective both organisationally and within their sphere of influence and activity. It is suggested that universities have a major role to play in tackling the sustainability agenda (Jones *et al*., 2008). The universities and colleges are in a unique position to lead the way and change the awareness of sustainability agenda (HEFCE, 2010). It is therefore expected that universities will be at the forefront of embedding sustainability both within their own institutional values and the curricula that they deliver.

Dixon (2009) argued that there has been progress made in recent years in linking sustainability into professional practice globally but suggested that the key barriers are lack of knowledge and expertise from graduates and experienced professionals. At the EcoBuild conference in 2010, Paul Morrell, the then government adviser on construction, stated that the government's greatest concern is how to satisfy the carbon and green agenda. He went on to state that the construction industry does not have the capacity to meet the sustainability agenda because the universities are not producing graduates with adequate knowledge.

It is therefore crucial for the construction sector to make significant contributions to sustainable development. Architects and engineers are providing leadership in sustainable construction in the world. However, there is lack of evidence showing that QS professionals are demonstrating sustainability leadership in the business environment. It is therefore of paramount importance to identify what types of new skills are required by quantity surveyors to tackle the sustainability agenda. The RICS (2007) review identified competencies and new skills required for QS to provide sustainability services through the life span of a building project. The areas identified are: value for money, whole life costing, cost of alternative materials, renewable energy schemes, recycled content schemes, the ethical sourcing of materials and labour. Other key elements also discussed in the literature include: sustainable procurement and sustainability performance measurement. Furthermore, the RICS also identified specific responsibilities for QS in sustainable development:

- Protecting and enhancing the natural environment
- Encouraging the sustainable use of resources
- Reducing waste generation and responsible disposal of waste
- Reducing energy consumption
- Promoting community development and social inclusion
- Minimising any negative social or environmental impacts of development
- Promoting sustainable land use and transportation planning and management
- Promoting sustainable design, development and construction practices, including whole-life costing.

However there is a huge knowledge gap for those studying QS in higher education. Embedding sustainability within the QS curriculum will require an exploration of its three spheres: economic, environmental, and social dimensions. In addition, knowledge of regulatory and technological issues is important as cross-cutting themes. Dale and Newman (2005) argued that the key to achieving these skills is adaptability, and the ability to change, particularly in an evolving economic climate with threats of climate change. Clearly universities operating in the built environment have a vital role in shaping the future pattern of practice and policy in relation to the sustainability agenda. So, it is essential to map the curriculum to capture the sustainability content. This will enable staff to educate and, inspire and influence the new generation of quantity surveyors or design economists to be tomorrow's leaders in sustainable development.

## 27.3 Development of the Sustainability Framework

In developing an appropriate strategy that will embed sustainability education within the built environment curriculum, a case study approach was adopted using three methods of data collection: use of published sources to identify the key components of sustainability education; structured interviews with academic staff involved in the decision making to establish the key categories of sustainability relevant to built environment professionals; and document analysis to determine the extent of sustainability topics in the curriculum based on the module descriptors. The coverage of sustainability in the current QS curriculum was identified and ideas on how to improve sustainability education in the QS degree programme were suggested.

The case studies include four RICS accredited QS degree programmes. The curricular of the programmes (module specifications) were mapped at detailed level using amount of time spent, that is module credits (as a depth measurement). The ensuing mapping was then verified for accuracy and consistency with programme directors responsible for delivery of these programmes. The four case studies selected were leading QS honours degree programmes in the UK all accredited by the RICS. There are a total of 360 Credits equivalent to 3,600 hours of learning in a degree programme. The depth measure reflects the amount of time spent on achieving a competency. In degree programmes, time spent on achieving module outcome is stipulated as Credits. Where 10 hours spent is considered as 1 Credit, a typical 20 Credits point module reflects 200 hours of learning by the student. This constitutes direct contact with formal teaching; lectures, seminars, tutorials as well as students' expected study time on the module content (time spent on their own). The depth measure is only indicated at competency level and not at topic level as it is impractical to stipulate expected number of study hours spent at a detailed topic level. A percentage score is used to indicate the proportion of time spent on each competency to provide a valuable measure to understand the relative time spent for each competency. The depth vector scale mappings of the four case studies were initially carried out using the respective module specifications of programmes. The results were sent out to the programme leaders of the degree programmes for necessary adjustments and validation. Descriptive statistics such as mean and percentage scores were used to analyse the results of the case studies as a conceptual benchmark.

The literature findings, document analysis and the interviews led to the development of the final sustainability framework which identifies the knowledge areas relevant to the QS degree programme and the profession. The framework has been developed in the light of the current and future roles of the professional quantity surveyor as informed by the sustainability agenda. According to the findings from the research, QS graduates will need to have awareness and knowledge of the issues identified in the framework (though to differing levels of detail) to be capable of delivering their professional responsibilities in the built and natural environments now and in the future. The refined framework (Table 27.1) categorises the sustainability-related knowledge areas relevant to QS education into six main categories (high level categories) with several sub-categories (low level categories).

### *Category A – background knowledge and concept*

The low level categories identified in the framework under high level category A are relevant to QS education and should be taught but it is questionable whether they are being taught under the current education system. There is a need to understand the principles of sustainable development, to have a background understanding of climate change and global warming issues which most students are already aware of. It is suggested that the latter should not take more than half a lecture and should not be taught in too much detail. Students need to be taught the history that led to sustainable development, and how it linked to climate change and global warming issues. The sustainable construction concept should have greater emphasis in QS education. Students need to know the link that exists between all the identified sub-categories and the roles of QS, why they are learning these and their application in the industry. It is agreed that the identified sub-categories are exhaustive and the advisory role of QS in sustainable development should be taught in more detail and greater depth under background knowledge and concept. All the sub-categories should always be linked to QS roles.

### *Category B – policies and regulations*

The only module that will address the sub-categories identified is the Sustainable Development module taught at Level 4 or possibly any of the Technology modules which will not be addressed to a satisfactory depth. Building regulations and Code for Sustainable Homes are not covered although Energy Performance Certificate (EPC) might be covered in the Building Services optional module taught at Level 5. Category B is vital and should be covered in the QS education especially the Building regulations and Code for Sustainable Homes which are central to the degree programme. QS students have to be able to advise the client accordingly. Students should also be familiar with the sustainable construction strategy and sustainable procurement action plan. However, the students are never examined on these topics and there have been possibly no exam questions in the past. Testing their knowledge on how they can advise clients in these areas is therefore important. Even though there is a piece of course work on the Sustainable Development module taught at Level 4, it is not QS specific.

### *Category C – environmental issues*

Most of the sub-categories identified under this main category are not covered and at best it tends to receive a superficial treatment. Part-time students are sometimes aware of these issues based on their experience at work. Moreover,

**Table 27.1** Sustainability framework relevant to QS degree programme.

| | SUSTAINABILITY FRAMEWORK | | | | | |
|---|---|---|---|---|---|---|
| **HIGH LEVEL CATEGORIES** | **CATEGORY A – BACKGROUND KNOWLEDGE AND CONCEPT** | **CATEGORY B – POLICIES AND REGULATIONS** | **CATEGORY C – ENVIRONMENTAL ISSUES** | **CATEGORY D – SOCIAL ISSUES** | **CATEGORY E – ECONOMIC ISSUES** | **CATEGORY F – TECHNOLOGY AND INNOVATION** |
| **LOW LEVEL CATEGORIES** | Sustainable development overview and principles<br>Climate change and global warming issues<br>Impact of the construction industry on the environment<br>Sustainable construction concept<br>Role of QS in sustainable development | Changes to Building regulation, e.g. Part L (energy efficiency) and Part F (means of ventilation)<br>Code for Sustainable Homes<br>Energy Performance Certificate (EPC)<br>The Kyoto protocol<br>Relevant EU Directives such as the EU climate policy, EU ETS, etc.<br>Climate Change Act<br>Sustainable Construction Strategy<br>Sustainable Procurement Action Plan | Protecting and enhancing the built and natural environments<br>Environmental Impact Assessments (EIA)<br>Environmental Management Systems: ISO 14001<br>Environmental Assessment Methods: BREEAM, LEED, Green Star<br>Reducing energy consumption, that is, emitted and embodied<br>Reducing greenhouse emission such as methane, carbon, nitrous oxide and refrigerant gases<br>Carbon Agenda (Carbon footprinting, Zero Carbon, Retrofit)<br>Waste reduction principles (recycling, reduction, reuse, effective design)<br>Brownfield development<br>Natural resources, renewable and non-renewable materials<br>Water usage and Sustainable Transportation Plan | Corporate Social Responsibility (CSR)<br>Ethical issues such as ethical sourcing of materials and labour, for instance<br>Equity and social justice<br>Community development and social inclusion<br>Health and safety<br>Employment, training and education<br>Social assessment methods (e.g. Design Quality Indicators, KPIs and benchmarking, etc.)<br>Cost Benefit Analysis (i.e. impact of human factors on the community) | Cost planning and management<br>Value management or engineering (cost of alternative materials and designs)<br>Sustainable procurement strategies<br>Feasibility studies<br>Whole-life appraisal/Life cycle costing<br>Financial incentives (such as subsidies, climate change level, aggregate tax, carbon credit, Brownfield land tax, etc.) | Renewable energy technologies (Photovoltaic, Wind Turbine, Geothermal, Biomass, etc.)<br>Green Building Materials<br>Rain water harvesting and Grey water collection systems<br>Professional and management software packages such as BIM, etc.<br>Modern methods of construction: offsite production, use of precast material, lean construction, etc.<br>Passive design methods such as day lighting, intelligent facades, carbon storage and offsetting, etc.<br>Supply chain management<br>Effective information control and management (using e-business) |

how much a quantity surveyor has to know about this category is questionable. Having general knowledge and awareness of the issues in this category may be enough. For example, Environmental Management Systems and Environmental Impact Assessment are relevant to a contractor, architects, other designers and clients who tend to be more aware of these issues. QS students need awareness of some of these issues in the Technology lectures but the traditional role of QS which involves the economic aspects still needs to be brought to focus. A minimum amount of understanding is required for this category so that a quantity surveyor could be effectively involved from project inception to completion.

## Category D – social issues

Public sector clients are more likely to be interested in Category D, as private sector clients are generally more interested in cost. A participant in the study argued that "Everyone knows the importance of local sourcing of labour and materials to support the local economy for instance, this is very obvious, but I am not interested in the level at which we teach this to QS students". Cost Benefit Analysis and other Social Assessment Methods are important and would be of interest to QS. It was further argued that the environmental issues, polices and regulations are more important aspects than social issues. Even though there is a sympathetic view on the impact of social aspects sustainability, the other areas are considered more relevant to QS education due to the time factor. Private sectors will need to be educated when it comes to social issues as they are more interested in cost, not the social impact of their development.

## Category E – economic issues

These are far more relevant and very important to QS education; cost planning and management, value engineering, feasibility studies, life cycle costing and financial incentives. Quantity surveyors should be fully aware of the financial incentives available so they can encourage their clients to use different sustainable technologies. Good examples include households that received some financial incentives as a result of using ground source heating. New graduates having this sort of up to date knowledge to take into the industry will be very beneficial for the companies they work for and their clients. The sub-category list for the Economic issues includes all relevant topics that should be taught under economic aspects of sustainability.

## Category F – technology and innovation

All the sub-categories identified here are relevant and should be taught in line with Category E using the analogy of Measurement and Technology module where the students are taught the relevant construction techniques and later taught how to measure them. The different technologies that could achieve sustainable development should be taught to QS students in parallel with how to measure and cost them. This way the quantity surveyor will be able to advise clients on the life-cycle cost implications of sustainable design technologies, which is the ultimate goal.

## 27.4 Mapping of Sustainability Education in QS Degree Programmes

A method of mapping sustainability education to curricular was developed as there is no standard method to compare the level of attainment of sustainability. A scoring approach was devised to systematically analyse the extent of mapping of sustainability education to individual modules of four RICS accredited QS degree programmes (Case studies A, B, C and D). These results are presented in the following section.

### *Level of Sustainability Education in QS degree programmes*

The analysis undertaken was to establish the extent of sustainability education in the different QS degree programmes. The analysis of the four case studies revealed that there are considerable variations in the degree programmes on how sustainability education is taught and delivered (Figure 27.1). Figure 27.1 shows a massive difference between the highest (Case study C) and the lowest (Case study B) coverage. The reason for this significant variation is attributed to the fact that Case studies C and D are considered as research intensive universities. Incorporating sustainability in their curricula was much easier and less demanding because the majority of the staff are active in research. Individual module contents also varied in greater detail than the generic comparison presented here.

### *Framework mapping in QS degree programmes*

This research also considered how the formulated framework was mapped within the degree programmes (i.e. Case studies A, B, C and D). These also revealed massive variations in the various categories (Figure 27.2). Figure 27.2 shows that Category F (i.e. Technology and Innovation) received the most

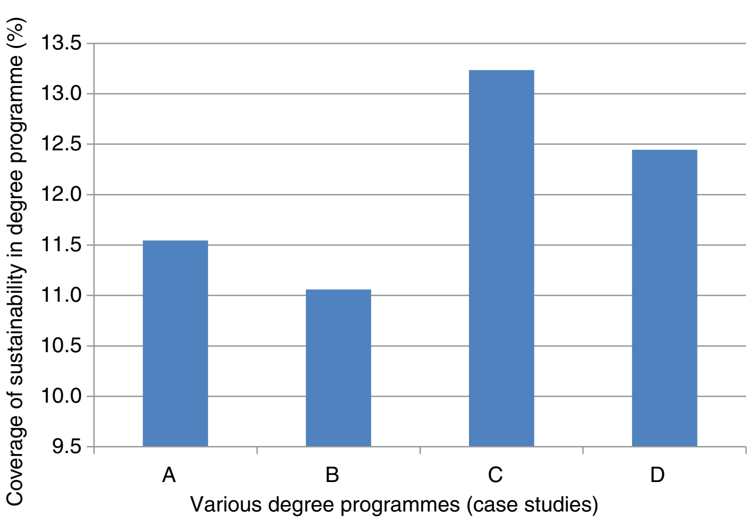


**Figure 27.1** Coverage of sustainability in QS degree programmes.

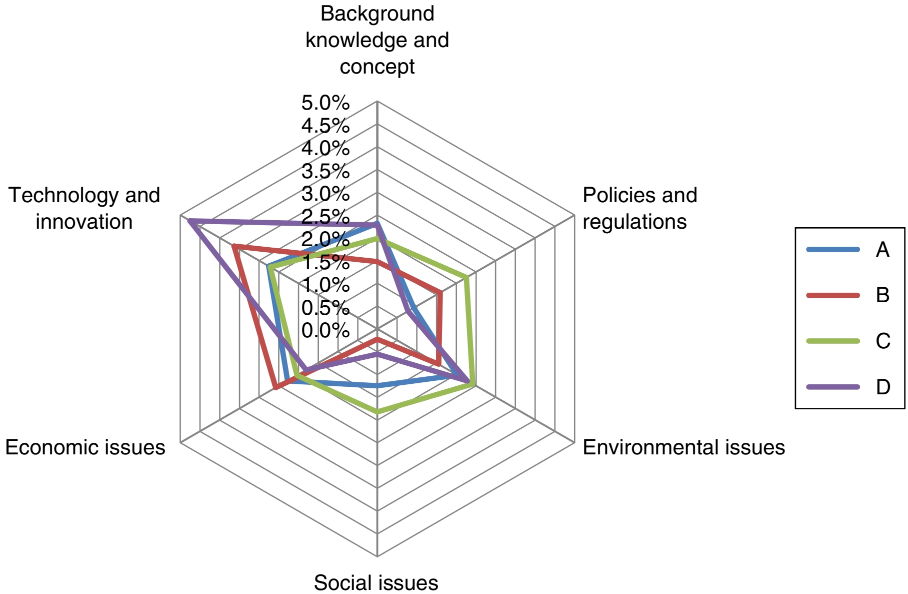


**Figure 27.2** Sustainability framework mapping in the four case studies.

attention and understanding by the staff and the programmes. This can be attributed to the argument that there is some synergy between sustainability and technology/innovation in the construction field. Figure 27.2 also reveals that Category A (i.e. Background Knowledge and Concept) was also high on the agenda of most universities. However, it seems limited in Case study B which is a less research intensive university, and staff do not feel confident to teach contemporary issues because of lack of up-to-date knowledge and skill. This is one of the factors that hamper and prevent adequate coverage of sustainability education in the curriculum.

## *Mapping of sustainability education at various Stages (i.e. Levels 4, 5, 6)*

It was considered imperative to consider at various stages of students' development how the QS degree programmes mapped the sustainability agenda.

The next section presents a summary of the sustainability education, QS degree programme and sustainability framework, extent of coverage and ideas on promoting sustainability education in QS degree programme based on the literature review findings and content analysis of the interviews conducted.

## *Summary of key findings*

- There is no prescribed threshold benchmark standard for achieving a decent level of sustainability education at undergraduate level.
- There is a clear lack of understanding or common agreement of what sustainability construction is or should be and this is hampering a structured agenda with the QS programmes.

- Although this research work has formulated a framework, in practice (i.e. universities) there are no detailed specifications to indicate what content should be covered to achieve a reasonable knowledge of sustainability for graduates.
- Different universities aim to achieve sustainability education at different levels, based on their own interpretation.
- There is no standard way or formal mapping process of sustainability education available for universities in curricula development or revision.
- There is no formal training for staff who consider themselves out-of-date to acquire current and contemporary knowledge and skills on sustainability.

## 27.5 Discussion and conclusions

Awareness is growing amongst the general public, encouraged by politicians at local, national and international levels, of the need to reflect upon the relentless consumption of resources by the growth of the built environment.

The industry will not survive by mere reflection and associated promises but, rather, by making best use of those scarce and sometimes non-renewable resources and by seeking sustainable solutions for the long-term future. Those involved in the construction industry will be key players, particularly the quantity surveyors with their perspective on the economics of design or construction which will be crucial. However, this "economic perspective" must be expanded beyond capital cost of construction (the traditional boundary of their skill) to embrace life time cost of the buildings, districts, cities, together with the infrastructures which serve and link them in the built environment.

This chapter has examined the core body of knowledge currently taught to students on four QS degree programmes. It is held that these graduates, together with other construction professionals, will be responsible for shaping and managing the built environment in the coming decade. Through a series of interviews with key staff, that is those responsible for developing and directing the programme at universities, a set of criteria was created, within broad categories referred, which could be tested on programme leaders from a sample of four universities from across the UK, each offering QS degrees. The study revealed the role which sustainability plays in the undergraduate studies at all four, and thus the importance attached to it. Six key categories were identified (A–F) which extended beyond background knowledge and the purely technical to cover political, social, economic and general environmental issues – in line with the "global" and cross-discipline nature of the problem of sustainability.

The study indicates that there is quite a large sustainability-related void in the education of student quantity surveyors, and quite possibly those in other construction disciplines. The total percentage of the curriculum devoted to Categories A–F range between 11% and 13%. As may be expected within a QS tradition, technology and economic issues (in this case chiefly a reference to cost-related capabilities) tend to be the areas where there is most concentration of teaching. Only two of the four universities focus on the broader environmental issues. Policies, regulations and social issues appear to receive the least attention.

Discussion with participants has indicated two possible causes of the void. First, it appears that realisation of the very real threat of sustainability is only just becoming apparent to those in academic institutions and to the professional bodies, who to a significant extent direct the pattern of the curriculum. Secondly, a limited number of academics have enough detailed knowledge of sustainability-related issues to incorporate into the subject confidently within the materials they deliver. They themselves were educated when the sustainability debate was not a top priority in the academic agenda. To some extent, education on matters of sustainability needs to be extended up the chain, to those academic programme leaders planning the curriculum, staff doing the teaching as well as down to the students who will be the future leaders.

One practical reason cited for the apparent failure to recognise and address the significance of the sustainability issue, often given in apology and sometimes as an excuse, is the lack of spare time or space within the existing curriculum. “So much to teach, so little time within which to teach it” is the cry. Indeed, this is already apparent from the varying emphasis placed upon the categories referred to above, the most time being afforded to the technical. However, awareness of the sustainability agenda and its importance is vital for the survival of the QS profession. Social and environmental issues drive the broader agenda. Therefore, whilst it is not suggested that academics should talk of nothing else, the research implications suggest that they might plant an awareness of its relevance to most things, emphasising to a greater or lesser extent its importance across the whole of the existing curriculum. To certain subjects such as Law and Management it may indeed seem and be somewhat peripheral but to Construction Technology and Construction Economics, for example, it must surely be of fundamental importance.

The examination of the existing curriculum and of curriculum leaders’ perceptions of its content and delivery at one institution suggests some uncertainty as to exactly where, and how, sustainability-related issues should be delivered. It is hoped that eventually it will be possible to produce a template, illustrating the relevance of sustainability to each key subject area, and ways even by which it may be effectively incorporated. A number of specific suggestions were made both as to the general direction teaching might take, and on specific areas worthy of increased emphasis within the syllabus. There is a general consensus and agreement of the appreciation of the sustainability agenda which should be a thread visible through all teaching at all levels. It was suggested that where a multidisciplinary School set-up existed, every opportunity should be taken for students of differing disciplines to work through the sustainability issues together, as they will have to in their professional careers. There was also an agreement that, where possible, classroom work should take as its model, data from local schemes which exemplified good practice in sustainability. Also, current research has much to offer and it is agreed that the technological and cost implications were crucial, together with the ability to transmit these concepts effectively to clients.

Participants agreed that: ‘[whilst] quantity surveyors are not there to advise on designs for sustainable development, which is the designers’ job really [they] should be trained as design economists to understand the technologies involved and their implications more in terms of costs’.

The current research supports the findings of RICS research by Perera and Pearson (2011), where sustainability was ranked low in terms of the content of the curriculum at present, although the same research shows that a growing body of professionals in practice do recognise the part it must play in their future workload. Surely academic institutions must do better to equip the quantity surveyors or tomorrow's design economists for what will undoubtedly be a pivotal role, in terms of the management of time, cost and quality in deciding the future costs to society of sustaining the built environment.

As one interviewee remarked: "Sustainable development is not going to go away… students are going to go out there in the next couple of years upon graduation to confront these issues which [are] out there and [are] not going to go away". To echo an earlier statement, we shall not survive, as educators, by mere reflection and associated promises. Our delivery and content must change to address this challenge of our age.

This chapter has presented the results of a study carried out in QS degree programmes to establish the content of sustainability education within the curriculum. The research is part of larger research which aims at diffusing sustainability into the curricula of all built and natural environment programmes. This research and other research have established that a holistic understanding across the disciplines is needed to accommodate the evolving concept of sustainability. Consequently, future research is needed to extend or map the sustainability education within other construction related programmes to enable decision makers to have a better understanding of the situation. Also, it is of paramount importance for this research to consider and explore the link with other stakeholders. Thus, a key strategy for incorporating sustainability education within the construction related programme would be to include professional bodies, industry and students in the research (Figure 27.3).

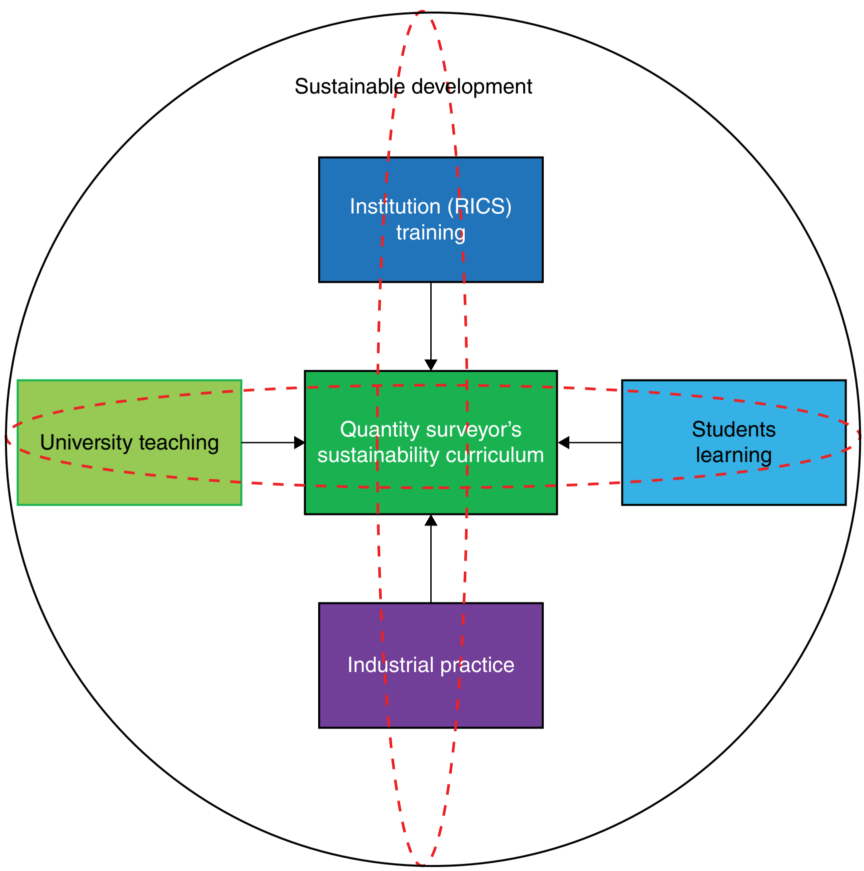


**Figure 27.3** A holistic view of the QS sustainability research strategy.

Figure 27.3 shows that for any meaningful strategy, the input from the various stakeholders is necessary to establish what is required and how the strategy will be implemented. Finally, it is anticipated that this strategy will lead to the development of a methodology that schools or universities generally can use to incorporate sustainability education within their curricula it is expected that there will be profound changes in the QS curriculum. This will ensure that the education and professional training of design economists is fit-for-purpose to continue to play a leading role in achieve sustainable design and cost effective solutions for the built environment.

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# SUSTAINABLE DEVELOPMENT IN A CONSTRUCTION RELATED CURRICULUM – QUANTITY SURVEYING STUDENTS' PERSPECTIVE

**Amelia TAN [a], Chika UDEAJA [a], Solomon Olusola BABATUNDE [a,*], Damilola EKUNDAYO [b]**

[a] *Faculty of Engineering and Environment, Northumbria University, Newcastle upon Tyne NE1 8ST, UK*
[b] *Faculty of Technology, Design & Environment, Oxford Brookes University, Gipsy Lane, Oxford OX3 0BP, UK*

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**ABSTRACT.** Higher education institutions (HEIs) across the globe are increasingly aware of the need to integrate sustainability education within the curricula. This triggered a number of studies were conducted by earlier researchers in embedding sustainability education within the curricula. Thus, studies have been carried out to evaluate how students perceived sustainable development in their curricula, particularly in engineering and other related courses. Few of these studies were conducted in built environment, most especially in quantity surveying. It is against this backdrop that necessitated this study. The purpose of this study is to establish the extent in which sustainable development is embedded in the construction related curriculum using the perception of quantity surveying students. The study adopted literature review, documentary reports among others as a secondary method of data collection. Primary data were collected through online questionnaire survey administered to 330 randomly selected quantity surveying students in a university in the UK. Out of which 87 completed questionnaires were retrieved and suitable for the analysis. The quantitative data obtained were analysed using mean score, one-way analysis of variance (ANOVA) and regression analysis. The study identified 46 sustainability topics, which were grouped into 6 categories (i.e. A–F). Based on these categories, the study found that students' knowledge level on sustainability was a little above 'basic/limited knowledge with the overall mean score value of 2.38 on a 4 – point Likert scale. The study further revealed that the students placed high importance on sustainability education, despite their knowledge level were found lower. The study findings would be used to establish the extent of sustainability within the curriculum in the quantity surveying programme. Also, this study would be of great value to academic staff and University management boards to develop a framework for incorporating sustainability education in the curriculum.

**KEYWORDS:** Quantity surveying; Sustainability; Sustainable development; Construction industry; Education; Students and stakeholders

## 1. INTRODUCTION

Climate change, degradation of ecological balance, and diminution of natural resources are visible signs that the earth's bearing capacity is not infinite (Abdul-Wahab *et al.* 2003). In tackling these issues, the governments around the world have been very keen on promoting the concept of sustainable development (SD), which seeks to meet human needs while ensuring the sustainability of natural resources and the environment, so that these needs can be met not only in the present but also for the future generations (World Commission on Environment and Development 1987). In the UK, the SD has drawn so much interest since the field first attracted attention in the 1980s. Achieving progress towards sustainability is critical to the future well-being of society; this has long been recognised by the government (Seyfang, Smith 2007; Cartlidge 2011). They have placed SD as a major objective both at a national and local sphere of influence and activity. Parallel to the SD trend in the UK, there is an increasing demand, in the construction sector, to understand sustainable design and construction practices (BERR 2008). This demand is driven by the realization of the need for sustainable practices that not only help the environment but that can also improve economic profitability and improve the competitiveness of the construction organisations (Revell, Blackburn 2007; Tan *et al.* 2011).

* Corresponding author. E-mail: sobabatunde80@gmail.com

It is clear that SD is increasingly high up on the agenda of construction industry because government, clients, employers and related professional body are raising their standards in demanding for sustainability literate graduates (Murray, Cotgrave 2007; Darwish, Agnello 2009; Iyer-Raniga *et al.* 2010; Ekundayo *et al.* 2011; Lozano *et al.* 2013). It is thus crucial that students' education embraces and incorporate sustainability within the curriculum. There are many researchers in this area who believe that the sustainability agenda and construction related activities are intrinsically linked (Walton, Galea 2005; Cotgrave, Alkhaddar 2006; Hayles, Holdsworth 2008; Theron 2010). The rationale, therefore, for embedding sustainability issues within the construction curriculum is a powerful and imperative one. However, the responses from the colleges and universities that provide education for the construction professional are still patchy and minimal. It is increasingly recognised that the curriculum should incorporate sustainability or green issues and produce graduates that are confident of taking care of the environment without damaging it for future users. Hayles and Holdsworth (2008) argued that the 21st Century is seen as the time for the UK universities to embrace new working practices. This is especially important if the educational system is to continue to be competitive and also meet the needs of its increasingly demanding stakeholders.

Studying at higher education institutions (HEIs) is a basic route of knowledge and skills enhancement for built environment professionals. For instance, as the construction industry now moves into a new era where sustainability issues are required to be integrated into construction practices, the construction related professionals such as the quantity surveyors are expected to broaden and enhance their knowledge, skills and competencies to promote sustainability. This is not without challenges. For instance, literature has indicated the common barrier of SD is the lack of knowledge and skills of the professionals (Lewis *et al.* 2005; Dixon *et al.* 2008). Embedding sustainability in the Built Environment (BE) education is very important to address the issues in the industry, and research on effective pedagogies has been carried out to push for and improve sustainability education (Lewis *et al.* 2005; Iyer-Raniga *et al.* 2010; Niu *et al.* 2010; Cotgrave, Kokkarinen 2011). In particular, perceptions of students on sustainability are regarded by several researchers as one of the effective education tools for improving sustainability education. Iyer-Raniga *et al.* (2010) argued that students' perceptions are important to understanding whether the intended knowledge is delivered at the right level. In the general built environment education sector, few researchers (see Cowling *et al.* 2007; Iyer-Raniga *et al.* 2010; Cotgrave, Kokkarinen 2011) had explored students' perceptions to re-orient education to address sustainability. Existing studies in Quantity Surveying (QS) curriculum (see Perera, Pearson 2011; Ekundayo *et al.* 2011; Perera *et al.* 2013; Lee *et al.* 2013) have focused on QS competencies and their application in the delivery of QS degree programmes, and QS early training. Few of these studies that examined sustainability in QS curriculum (see Ekundayo *et al.* 2011) developed a sustainability framework relevant to QS degree programme. Despite these previous studies, there is a paucity of research investigating quantity surveying students' perceptions of sustainability. This study aims to fill this gap by establishing the extent in which sustainable development is embedded in the construction related curriculum using the perception of quantity surveying students. Achieving this is fundamental to understand whether the intended knowledge is delivered at the right level. Thus, this study becomes imperative to address the research question – "how students perceived sustainable development in their curricula in the built environment disciplines, most especially in quantity surveying?" In this respect, this study was guided by the following derived objectives:

- Empirically investigate the awareness and attitudes of QS students have towards sustainable development.
- Assess the level of QS students' knowledge, and identify knowledge gaps in QS – relevant sustainability knowledge areas.
- Explore the students' opinions towards sustainability education within the current QS curriculum.

It is believed that this study would be of great value to academic staff and University management boards to develop a framework for incorporating sustainability education in the curriculum. It is further anticipated that this study will contribute to improving the understanding of the knowledge of students on sustainable development, and positively influence their attitudes and behaviours when they graduate.

## 2. LITERATURE REVIEW

### 2.1. Sustainable development and the construction industry

Since the publication of the Brundtland Report (World Commission on Environment and Development 1987), sustainability has become an important topic in many industries both in the UK and globally. In the construction sector, the recognition of the importance of the construction industry for sustainability through agendas such as sustainable development (SD), sustainable construction, sustainable building among others has gained widespread momentum. Ganah *et al.* (2008) identified that construction activities represent complex activities that place a significant strain on the wider environment and also one of the major factors that determine the sustainability of a community. Ganah *et al.* (2008) further stated that buildings have a major environment impact over their entire lifecycle from construction to the demolition of the building structure. The relationship between the construction and SD is one which has been extensively explored and is well documented in research work (see Hill, Bowen 1997; Bourdeau 1999; Gilham 2001; Kibert 2007; Edum-Fotwe, Price 2009) among others. Kibert (2007) recognised the contribution of the construction sector to SD agenda could be immense. Boardman (2007) estimated that the construction in its widest sense is responsible for 40% of $CO_2$ emission, as well as 40% of all energy used. The industry faces ever-increasing problems in managing and dynamically responding to changes in the environment (climate changes) and the needs of their clients, particularly in the building sector (Meikle 2008). Moreover, the SD principles are increasingly seen not just as an issue of SD but as a valuable argument to address the technical process that determines the likely performance of a building or construction project. This emerging role presents new and considerable challenges for construction or building projects during its whole life. To attain the goals of green construction requires that the industry intensifies its efforts in embedding sustainability issues within the construction field.

There has been several industry and UK government attempts to encourage SD and, in particular, sustainable construction. Such attempts include the development of various sustainability assessment techniques in buildings such as the code for sustainable homes (CfSH), Building Research Establishment Environmental Assessment Method (BREEAM), and the Green Guide. Udeaja *et al.* (2013) added that initiatives such as green supply chain management (GSCM), green building, zero carbon homes, and carbon counting have been explored recently and they are all signs of growing recognition of the need for embedding SD in the construction field. Furthermore, the UK government have taken considerable measures to promote sustainability in the construction industry by developing a range of environmental tax, levy, regulations, incentives, and formalised methods of managing carbon (Pellegrini-Masini *et al.* 2010; Monahan, Powell 2011). It is clear why the construction industry must respond accordingly and focus its attention on developing sustainable buildings which are economically viable, socially acceptable and environmentally friendly. In particular, there continues to be greater emphasis on sustainable buildings with less impact on the environment (RICS 2012). Coupled with this is the increasing need for the judicious use of the irreplaceable, dwindling natural resources (Emmanuel, Baker 2012). Construction industry for a long time has worked tirelessly in achieving safe and SD in a cost effective, environmentally protective and socially responsible manner. The construction professionals of the future will need to be well equipped to account for all aspects of the construction given their broad roles from design to deconstruction of the built environment. Consequently, the construction industry must incorporate principles of sustainability wholeheartedly into each of its projects, so that its contribution to SD will be influential and finally beneficial to both human and economic developments. This means that the construction industry needs professionals who through education systems are trained and mindful of the SD issues and have the knowledge and competency to participate and contribute to the industry that can sustain rather than degrade the environment, economy and society in the long run.

### 2.2. Importance of embedding sustainability in education

The importance of the construction sector in addressing the issue of sustainable development (SD) is undeniable. The Brundtland report defines sustainable development (SD) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987). Also, SD seeks to address the balance between the environment, economy and society without compromising the need for future generation (Ganah *et al.* 2008). The three elements in the concept of SD – the environment, economy and society, are known as the "three pillars" of SD. Thus, it is imperative that the built environment (BE) in general embed sustainability principles within the educational and training of the future graduates to ensure that they possess appropriate knowledge, skills and value sets (Lewis *et al.* 2005; Murray, Cotgrave 2007; Darwish, Agnello 2009). Further, Darwish and Agnello (2009) emphasised the need to instil graduates with up-to-date knowledge and skills so that that they will be able to manage any uncertainties that may arise and also make a judgement on the available evidence in built environmental design and construction. Cortese (2003) stated that the higher education institutions (HEI) have "profound moral responsibility to increase the awareness, knowledge, skills and values needed to create sustainable future". HEIs are the most important primary sources of knowledge which are capable of enforcing and changing the attitudes, behaviours and practices of the professionals to embrace and promote SD. The argument for embedding sustainability in education is further reinforced by several initiatives around the world. For example, the Earth Summit in 1992 gave high priority in its Agenda 21 to the role of education in promoting sustainable development and improving the capacity of the people to address sustainable development issues (Grubb *et al.* 1993). Lozano *et al.* (2013) identified that the summit focused on the process of orienting and re-orienting education in order to foster values and attitudes of respect for the environment. Other initiative includes the 2002 Johannesburg Summit that has broadened the vision of SD and re-affirmed the educational objectives within the millennium development goals (MDG 2013). There is evidence that some progress in sustainability education has been made in the last decade, but much more remains to be done.

Despite the fact that progress has been made in incorporating sustainability education in curriculum, the extant literature have shown and revealed issues of irregular and inefficient engagement of the HEIs in delivering adequate competencies, knowledge, skills and attitudes required for achieving the goals of sustainability in the built environment (Cotgrave, Alkhaddar 2006; Ganah *et al.* 2008; Cotgrave, Kokkarinen 2010). The HEIs are facing challenges in embedding effective sustainability education into the curriculum. Hence, what is required is a suitable pedagogic strategy for SD education. Ekundayo *et al.* (2011) identified pedagogical strategy as an approach that collaborates with and gathers input from the industry, academia, students and professional bodies in order to reorient sustainability education.

### 2.3. Previous studies on students' perceptions of SD

Students' perceptions have long been recognised by the academia as one of the most important indicators of the effectiveness of education and a tool for overcoming shortcomings in education. Their perceptions serve as an effective yardstick for judging the progress, as well as determining methods and identifying areas for improvement in teaching and learning. Therefore, selected studies on students' perceptions of SD by earlier researchers are presented in Table 1.

It is evident from Table 1 that studies on students' perceptions of SD available, but very few of these studies were conducted in the built environment, especially from quantity surveying students' perceptions of sustainability in their curriculum. Assessing students' perceptions of sustainability should be continuous to constantly evaluate and improve curricula in higher education institutions (HEIs). This would enable the educational system to be competitive and meet the needs of its ever demanding stakeholders. It is on this premise that this study becomes imperative with a view to investigating how extent quantity surveying students know about sustainable development and determine the possible implications for their curriculum. This would be of great value to academic staff and University management boards to have a better understanding of the students' knowledge level on sustainability.

## 3. RESEARCH METHODOLOGY

This study adopted literature review, documentary reports, and questionnaire survey. A comprehensive literature review was conducted to identify sustainability topics. Thus, few previous research has established the content of sustainability education within the curriculum and mapped sustainability education within QS degree programmes by evaluating academic and industry perception (Ekundayo *et al.* 2011; Perera, Pearson 2011). This study, therefore, adopted the identified 46 sustainability topics in the sustainability education framework developed by Ekundayo *et al.* (2011) in the UK. The rationale for adopting these 46 sustainability topics was that it has been used to

Table 1. Students perceptions to reorient education to address sustainability

| Author and year | Focus | Students discipline | Study area | Methodology | Findings |
|---|---|---|---|---|---|
| Iyer-Raniga *et al.* (2010) | Investigating & comparing the level of sustainability understanding among graduating students | Property, Construction & Project Management | Singapore RMIT & Melbourne RMIT | Questionnaire survey | No significant differences in the perceptions, knowledge, and understanding of sustainability issue amongst Melbourne and Singapore students. The authors advocated for a new design of higher education construction curricula that contains sustainability in a broader context. |
| Cotgrave and Alkhaddar (2006) | Developing curriculum that promoted sustainability | Construction | Liverpool John Moores University, UK | Literature review, Questionnaire survey & Interviews | New curriculum was developed to accommodate sustainability. |
| Cotgrave and Kokkarinen (2011) | Testing students' perceptions and skills on sustainability after developing new curriculum | Construction | Liverpool John Moores University, UK | Questionnaire survey | Significant changes of students' towards sustainability. |
| Cowling *et al.* (2007) | Exploring sustainability perceptions of students over time | Kingston University School of Surveying (KUSS) | Kingston University, UK | Questionnaire survey | Students perceived environmental aspect of sustainability as the most important of sustainable development (SD). |
| Azapagie *et al.* (2005) | Exploring undergraduate students' perceptions of SD | Engineering | 21 Universities across the globe participated in the survey- 2 in Australia, 1 in Brazil, 1 in France, 1 in Germany, 1 in Italy, 1 in Sweden, 1 in Thailand, 2 in the USA, 2 in Vietnam, and 9 in the UK | Questionnaire survey | Low understanding of SD. However, strong knowledge of environmental aspect but limited knowledge of social and economic aspects of SD.<br>Identified that the students believed that SD is important for engineers but the students found it difficult in making a direct link between the theory of SD and engineering practice.<br>The authors suggested new engineering curriculum with a view to addressing identified challenges among engineering students. |
| Hanning *et al.* (2012) | Students' perceptions on SD | Engineering | Chalmers University of Technology, Sweden | Course documented text analysis, Questionnaire survey, Interviews, and Focus group discussion | It was found that industry demands a broader range of competencies in SD amongst engineers in general than what is currently provided. |
| Nicolaou and Conlon (2012) | Final year students' perceptions about SD | Engineering | Dublin Institute of Technology, Ireland | Questionnaire survey | It found that there were knowledge gaps in terms of society aspect.<br>Identified the causes of knowledge gaps. |
| Kagawa (2007) | Students' perceptions of SD | All faculties | Plymouth University, UK | Online questionnaire survey | Identified that students' perceptions were strong towards environmental aspect.<br>Significant gaps existing in the knowledge of social and economic aspects of SD.<br>Suggested new curriculum development to address sustainability in a holistic manner. |
| Drayson *et al.* (2013) | Students' attitudes and skills for SD | First and the third year students in all faculties | Universities across the UK | A two-phase methodology was conducted: Desk-based research i.e. reviews of existing policy-based research, and online questionnaire survey | Identified that over eight in every ten students were consistently believed that SD should be actively incorporated and promoted by universities.<br>Identified that over two-thirds of students believed that SD should be covered by their universities courses.<br>Identified that over 60% of students want to learn more about SD. |
| Watson *et al.* (2013) | Examining students' perceptions of sustainability | Civil and Environmental Engineering | Georgia Institute of Technology, USA | Questionnaire survey | Identified that students were interested in SD and there is potential for further enhancing sustainability learning. |

capture the perceptions of academic staff in the universities and industry professionals in the UK. The sustainability education framework that contained the identified 46 sustainability topics is presented in Figure 1.

As shown in Figure 1, the identified 46 sustainability topics were grouped into 6 categories (i.e. A–F). Thus, these 46 sustainability topics were incorporated to design a questionnaire survey. A quantitative method was used to evaluate students' knowledge and perceptions of the identified 46 sustainability topics, due to its suitability for large sample size and its ability to produce precise and generalisable statistical findings. Also, quantitative method has been widely used in similar studies to capture students' knowledge and perception of curriculum and to delve into their awareness and satisfaction of the same (see Azapagic *et al.* 2005; Cowling *et al.* 2007; Kagawa 2007; Cotgrave, Kokkarinen 2011; Nicolaou, Conlon 2012; Watson


Fig. 1. Sustainability framework relevant to QS degree programme (adapted from Ekundayo *et al.* 2011)

*et al.* 2013). An online questionnaire survey was conducted to allow a large quantity of samples to be collected efficiently and within available resources. The online questionnaire survey adopted the design used by Azapagic *et al.* (2005) for engineering students but with modifications to suit this study. The target population for this study is quantity surveying (QS) students comprised both full-time and part-time undergraduate students in a University in the UK. The full-time course is 3 years, and the part-time course follows a similar study pattern to full-time but it takes a longer time of 5 years to complete the degree. Therefore, 330 QS students at the undergraduate level of the study were randomly selected for this study in an RICS accredited University in the North East of the UK. The reason for selecting a University is that this study is a follow-up of research conducted by Ekundayo *et al.* (2011) in which a sustainability framework relevant to QS degree programme is developed from academic staff in a university and industry professionals' perspectives without considering the perceptions of QS students of that university. It against this background that this study considered the QS students of that university with a view to capturing their perceptions on knowledge levels of sustainability topics already identified by Ekundayo *et al.* (2011). Prior to data collection, a pretesting study was initially undertaken to test the validity of the questionnaire. The pretesting was conducted with a total of 8 final year undergraduate students and slight alterations were made based on the feedback. A minor issue arose following the pretesting concerning whether the definitions of some terms be defined and explained in the survey. In the end, definitions of some terms were included in the cover email. Furthermore, a reliability test using Statistical Package for the Social Sciences (SPSS) was conducted on the questionnaire. The result indicated the reliability coefficient value of Cronbach's alpha 0.851 signifying that the questionnaire used was significantly reliable and indicates evidence of internal consistency (see George, Mallery 2003). Thus, a total of 330 questionnaires were administered, out of which 87 representing 26.36% were completed and suitable for the analysis. The effective response rate of 26.36% was slightly high compared to similar earlier studies. For instance, Lee *et al.* (2013) achieved a response rate of 10% when administered questionnaires to quantity surveying graduates in their early careers in the UK. Also, based on Bartlett *et al.* (2001) calculation to determine an appropriate sample size in survey research for a population exceeding 300 is 85. Therefore, the received response of 87 satisfies this requirement. The questionnaire for this study was divided into four main sections aiming to capture students' demographic data; their level of awareness of sustainable development; their knowledge in QS-relevant sustainability topics; and their perception of sustainability education within the QS curriculum. A pilot study was initially undertaken to test the validity of the questionnaire. Respondents were asked to rank their answers on a 4-point Likert scale with 4 being the highest of the rating. Data collected were analysed using both descriptive and inferential statistics. Such as percentiles, mean item score (MIS), one-way analysis of variance (ANOVA) and regression statistics. MIS was used to establish the relative level of knowledge of the students and the perceived importance of the sustainability topics. MIS was used to rank the collected data to get the average of the obtained variables. Percentiles, that is, ratios multiplied by 100 were also used in rating a number of factors according to the degree of occurrence attached to them. The higher the percentage rating, the higher the importance or significance attached to such factors. The essence of percentile is to allocate a value between 0–100 to a factor (100 being the highest possible value) using factor size and total size. The formula is; $P = n*100/N$, where P is the percentage of the factor, n is the size of the factor in consideration and N is the total size of the population. Mean item score (MIS) was used to analyse the Likert-scale data and is calculated using the formula as follows:

$$MIS = \frac{\sum n_1 k_1}{\sum N} = \frac{4n_4 + 3n_3 + 2n_2 + 1n_1 + 0n_0}{N_4 + N_3 + N_2 + N_1 + N_0}, \quad (1)$$

where: *MIS* = Mean item score; $\sum N$ = Total number of respondents; $N_4$ = the number of respondents that choose 4, etc.; 0–4 = the various marks for the ranking of the factors as applicable in each case.

One-way analysis of variance (ANOVA) test was used to test the difference in the level of sustainability knowledge of students in the different years of study. The test was undertaken at 95% confidence level, that is, the level of significance is 5%. Once the significance of relationship was established, the effect size measure for ANOVA, also known as "eta squared ($\eta^2$)", was later used to test how large the differences are, using the formula:

$$\eta^2 = \frac{\text{Sum of squares for treatments}}{\text{Total sum of squares}}. \quad (2)$$

The results generated from the "equation 2" above were then interpreted using Cohen's guideline of $\eta^2$ value, where: 0–0.1 is a weak effect; 0.1–0.3 is a modest effect; 0.3–0.5 is a moderate effect; and >0.5 is a strong effect. In addition, regression statistics was used to test the relationship between the level of knowledge of students and their year of study. Similarly, its significance was determined by 0.05 level in p-value. R-squared ($R^2$) value was used for the regression test to determine the strength of the relationship between the variables and then interpreted as follow, where: <0.1 is a poor fit; 0.1–0.3 is a modest fit; 0.3–0.5 is a moderate fit, and >0.5 is a strong fit.

## 4. FINDINGS AND DISCUSSION

Table 2 shows the distribution of questionnaire and demographic characteristics of respondents. The table indicates a total of 330 questionnaires administered, out of which 87 questionnaires were retrieved representing 26.36%. Table 2 further reveals the breakdown of respondents to include gender, age, origin, mode of study, and level of study. It can be seen from Table 2 that 57 of the respondents are male representing 66% while 30 of the respondents are female representing 34%. The age of respondents reveal that 86% of the respondents are between the age of 18 and 25 years, 9% are between the ages of 26–35 years, and 5% are between the ages of 36–45 years. Also, QS undergraduate programme is either studied as BSc (Hons) 3 years full-time or 4 years sandwich or as BSc (Hons) part time for 5 years in the UK universities. Therefore, as shown in Table 2, the respondents' mode of study indicates that 90% of the respondents are full-time students and 10 % are part-time students. Also, the respondents' level of the study reveals that 13% are in level 4 (i.e. the first year in the university), 43% are in level 5 (second year in the university), and 44% are in level 6 (final year in the university). It can be seen that all the respondents are undergraduate. Also, most of the respondents are at higher levels (see Table 2 for details). Based on the respondents' age, mode of study, and level of study has been described afford the respondents to give accurate and reliable information.

Table 2. Total and breakdown of responses according to different variables

| Demographic characteristics | | Number | Percentage (%) |
|---|---|---|---|
| Total number of respondents | | 87 | 100 |
| Gender | Male | 57 | 66 |
| | Female | 30 | 34 |
| Age Group | 17 and under | 0 | 0 |
| | 18–25 | 75 | 86 |
| | 26–35 | 8 | 9 |
| | 36–45 | 4 | 5 |
| | 46–55 | 0 | 0 |
| | 56–65 | 0 | 0 |
| | 66 and above | 0 | 0 |
| Origin | Developed countries | 56 | 64 |
| | Developing countries | 31 | 36 |
| Mode of study | Full-time | 78 | 90 |
| | Part-time | 9 | 10 |
| Level of study | Level 4 | 11 | 13 |
| | Level 5 | 37 | 43 |
| | Level 6 | 39 | 44 |

### 4.1. Students' knowledge level on sustainability

This is the second section of the questionnaire, respondents were asked to indicate their understanding in all the 46 sustainability topics in the sustainability education framework (see Fig. 1 for details). Therefore, Figure 2 indicates the mean item score (MIS) results of students (respondents) knowledge level on 46 sustainability topics, which were grouped into 6 categories (A–F) with their components. These include: Category A – Background Knowledge and Concept; Category B – Policies and Regulations; Category C – Environmental Issues; Category D – Social Issues; Category E – Economic Issues; and Category F – Technology and Innovation with their MIS values of 2.64; 1.99; 2.39; 2.15; 2.49; and 2.59 respectively. It can be deduced that students (respondents) appeared to have the most knowledge in Category A – Background Knowledge and Concept (2.64) and the least knowledge in Category B – Policies and Regulations (1.99) (see Fig. 2 for details).

This result is in contrast with few previous studies. For instance, Kagawa (2007) and Hanning *et al.* (2012) discovered students' understanding of sustainability was inclined towards environmental aspects. This difference could be attributed to the nature of the programme being studied. Whilst understanding of the technical aspects of sustainability may be critical in engineering degree programmes. Thus, the overall background and concept of sustainability may be more important in quantity surveying programmes. As shown in Figure 2 the MIS values for the 6 main categories ranging from 1.99 to 2.64, also, the overall MIS value of 2.38 (out of 4) representing 59.50%

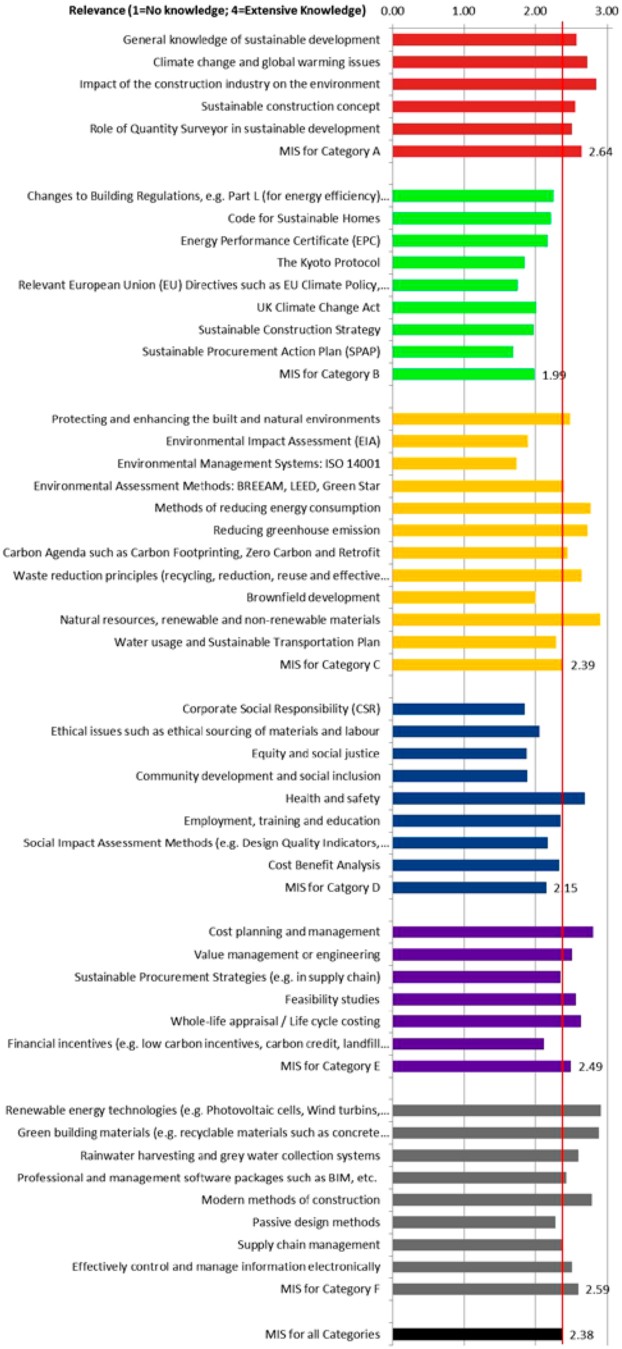
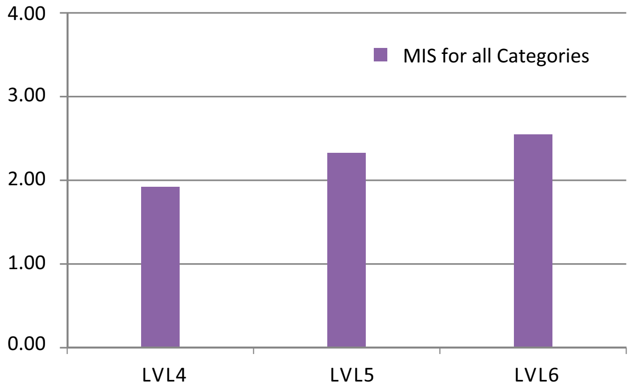



Fig. 2. Students knowledge level on sustainability topics

(see Fig. 2 for details). It can be deduced that students' knowledge level on sustainability was just above "basic/limited knowledge". This indicated that respondents had shown relatively balanced knowledge and understanding of the sustainability topics in this study (see Fig. 2). The reason behind this moderate level of students' sustainability knowledge may be partly due to the fact that the university of the respondents had approached sustainability education in a holistic and balanced way within a relevant context. Moreover, the possibility of respondents gaining knowledge and




**Note*: LVL4–Year 1 in the university; LVL5–Year 2 in the university; LVL6–Final year in the university.

Fig. 3. The knowledge level of students according to their level of study

awareness from sources other than the university must also be taken into account, especially with regard to part-time students who have relevant industry experience.

Based on the respondents' responses, the performance of students at different degree levels in sustainability knowledge was further analysed. Figure 3 presents a gradual increasing trend of knowledge level among students in each sustainability category as they progressed higher in education level.

As shown in Figure 3, the majority of the level 4 students (first-year students) had the lowest knowledge level whilst level 6 students (final year students) had the highest knowledge level on sustainability. To compare the sustainability knowledge level among students from all the levels of study, one-way analysis of variance (ANOVA) and a measure of effect size were carried out. It was found that the differences in the average scores between the three levels of study (see Fig. 3) were statistically significant ($p = 0.000$, $<0.05$) and $\eta^2$ of 0.54 ($>0.5$) suggested that the differences were large. In other words, the students at different levels of the study had a different level of access to sustainability knowledge. This may be explained by the university's role in transferring more sustainability knowledge as students advance to higher education level. Also, other possibilities such as students interests or media influence cannot be disregarded as a contributory factor.

To test the relationship between students' level of knowledge and their level of study, regression test and a measure of effect size were used. The p-value of 0.016 ($p < 0.05$) showed that the relationship between both variables was statistically significant. The adjusted $R^2$ value of 0.852 revealed that the relationship was strong ($R^2 > 0.5$) and that 85.2% of the variation in the level of knowledge could be explained by the year of study. In other words, the results indicate that level of study affects students' sustainability knowledge level. The results suggest that the university has been playing an important role in making education for sustainability a possible goal. It may have been increasingly preparing students to be more sustainability literate as they proceed to a higher level of education. It is important that students, especially final year students are equipped with sufficient sustainability knowledge to enable them pursue and promote the sustainability agenda after graduation.

### 4.2. Students' expectation

This is the final section of the questionnaire, the respondents were asked to give their opinions on the importance of the 6 main sustainability knowledge areas (see Fig. 2 for details). These were then compared with their sustainability knowledge in each of the 6 sustainability knowledge area. The essence of this section of the study is to identify the knowledge gaps and then determine how much more effort is needed by the university to satisfy students' needs. Knowledge gaps were discovered to have existed across all categories based on the MIS. This finding is similar to Azapagic *et al.* (2005) and Nicolaou and Conlon (2012) where students have no sufficient knowledge and understanding of sustainability. This suggests a need to narrow such gaps by the university. QS Students had the largest knowledge gap in Category B – policies and regulations and the smallest in Category A – background knowledge and concept (see Fig. 2 for details). One of the reasons may be that the university has not focused on teaching Category B as much as Category A or such topics tend to be handled by the professional bodies or government when the students need to be qualified as a member of the professional body. The identification of knowledge gap allows the recognition of the problem source Iyer-Raniga *et al.* (2010) which in turn can provide the educators with practical guidance on how to narrow knowledge gaps Azapagic *et al.* (2005). In other words, in this context, to improve the sustainability education within the QS curriculum, teaching should focus more on category B.

Figure 4 shows that the students generally exhibited higher levels of perceived importance on the knowledge of sustainability than their level of knowledge. The majority of the students perceived all categories as "Important" with overall MIS of 3.19 (see Fig. 4 for details).

In the light of students strong support for SD with a lower level of knowledge (see Fig. 4), they were conscious of the importance of gaining sufficient knowledge of sustainability from the university in order to be competent in participating in the SD agenda in the future. This highlights the existence of gaps between students' needs and expectations and their actual experience, which the university will need to address to maintain the practical relevance of their programmes. As pointed out by Kagawa (2007), in the process of embedding sustainability education, students' needs, aspirations, and concerns cannot be ignored. Clearly, these findings revealed that there is room for improvement in the current sustainability education within the QS curriculum. Therefore, students' perceptions of sustainability have offered an understanding of their awareness, attitudes, knowledge and opinion towards sustainability. Although sustainability education has been implemented

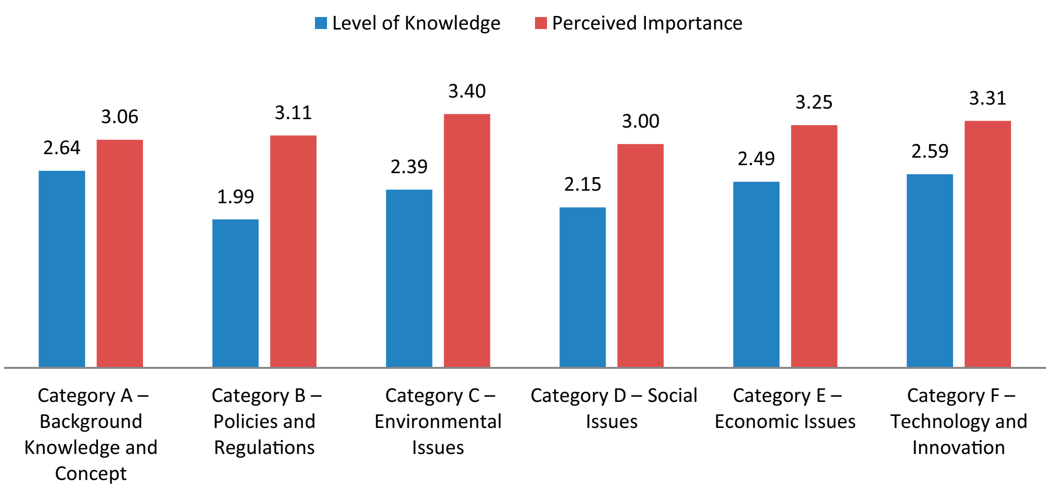



Fig. 4. Students' knowledge level and perceived importance of sustainability categories

within QS curriculum to a certain extent according to this study, the findings suggest that there is an urgent need to improve the present curriculum to ensure that sustainability education meets the requirements of QS students, as well as to increase their knowledge and influence their behaviour for their future undertakings.

## 5. CONCLUSION AND FUTURE RESEARCH

Sustainable development (SD) has become an inevitable trend in recent years, due to adverse environmental impacts, such as global climate change, degradation of ecological balance and diminution of natural resources. SD has gained its popularity and momentum within the UK and its construction industry through recent heavy government imposed legislations and regulations, increased standards of competencies from professional bodies, and vigorous institutional educations and researchers. The construction industry has been deemed as the prime mover of the economy as well as the main protagonist of SD. Thus, the quantity surveyors as part of the construction industry have an important role to play in order to help to balance out the environmental, economic and social problems caused by the construction industry. This study revealed that the students were aware of the concept of SD and majority of students held positive attitudes towards SD. This demonstrates that the role of the university in bringing awareness of SD to the students is successful and critical. It is also important that the university can nurture their positive attitudes further to enable them to engage in sustainability agenda more whole-heartedly. About the students' knowledge and understanding aspects, the study showed that the implementation of the curriculum has been successful to a certain extent in introducing SD holistically. This study further revealed that students in different years of study had a different level of knowledge and their level of knowledge was strongly related to their year of study. However, knowledge gaps were still found across all categories of sustainability knowledge areas. In particular, the largest gap was found in knowledge about policies and regulations endorsed by the government to promote SD. The study also revealed that the students placed a high importance of sustainability education despite knowledge level were found lower. This study is not without limitation. First, the respondents considered in this study were from only one RICS accredited University in the North East of the UK, considering other RICS accredited universities offering Quantity Surveying programme in the UK would have enhanced the credibility of the findings. Second, although the use of questionnaire survey allows the large sample to be captured, having other methods together such as interviews and the use of case study approach may enrich the findings. Despite its limitations, the findings emanating from this study prove to be more reliable as they come about not merely from a library investigation but rather from field work approach which involved getting students shared their true experiences. Thus, future research should be conducted to involve several universities on a periodical basis, and comparisons could be made to monitor the progressions of the curriculum, as well as the students' expectation of the sustainable development. Also, in future surveys, new topics need to be included in line with environmental, technological, governmental, economic and social changes. Similarly, further research is needed to extend or map the sustainability education within other construction related programmes in the HEIs. It might also be useful for the university to conduct a survey to monitor whether knowledge gained by graduates is put into actual practice or is relevant to their working careers.

These study findings revealed room for improvement in the current sustainability education within QS curriculum. Thus, the study recommends that:

- Teachings should focus more on category B – policies and regulations of sustainability knowledge areas.
- The task of embedding sustainability within QS curricula needs to be supported by a determined institutional ethos and continuously review.
- The university should be innovative and selective in teaching and imparting the knowledge deemed most important and least known to the students.
- Reorienting QS education i.e. there is urgent need to reorient existing QS education policies, programmes and practices so that they build the concepts, skills, motivation and commitment needed for sustainable development.

It is believed that this study would be of great value to academic staff and University management boards to develop a methodology for incorporating sustainability education into their curricula. The professional bodies will also benefit through using the 46 sustainability topics to establish the relevant competencies required for a graduate quantity surveying professional.

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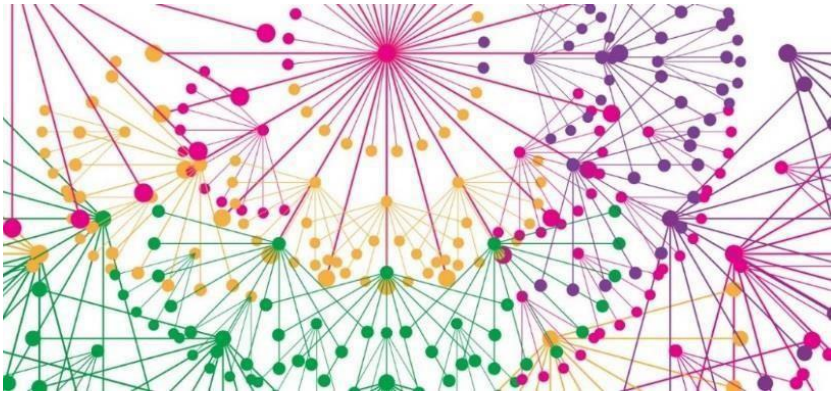

# Sustainable Ecological Engineering Design for Society (SEEDS)

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# TOWARDS THE DEVELOPMENT OF A FRAMEWORK FOR INCORPORATING SUSTAINABILITY EDUCATION IN THE BUILT ENVIRONMENT CURRICULUM

**Damilola Ekundayo, Chika Udeaja, Kwasi Gyau and Anthony Higham**

School of the Built Environment, University of Salford, The Crescent, Salford, M5 4WT, UK

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## Abstract

*Many proponents believe that there is a linkage between the green agenda and built environment (BE) education. It is increasingly recognised that the BE education curriculum should incorporate sustainability and produce graduates that are confident of taking care of the environment without damaging it for future users. Achieving education for sustainable development within the quantity surveying curriculum and more generally in BE curriculum will require an exploration of the general definition of sustainable development and its three spheres; economic, environmental, and social. In addition, one must acquire knowledge of regulatory and technological issues that encompass both the parts and the whole in dynamic interaction. Clearly, universities operating in the BE field have a vital role in shaping the future pattern of practice and policy in relation to the sustainability agenda. So, it is vital to map the curriculum towards sustainability. This research has been developed in response to the growing need of education for sustainable development. Whilst the study identifies the quality and quantity of sustainability related materials within existing BE curriculum, future research is needed to develop a modular framework for further integration of sustainability education in BE programmes. This framework could serve as an evaluation and a benchmarking tool for those who engage in developing the content of BE degree programmes.*

## INTRODUCTION

The sustainability revolution, which occurred over three decades ago, has culminated in the realisation that the world runs the risk of unsurmountable challenges if it does not embrace sustainability (cf. Miller *et al*., 2014). From the perspectives of proponents, the concept, which hinges on the future of humankind and the relationship between society and its natural environment, offers economic, socio-cultural and ecological benefits (Crofts, 1999). These benefits, as argued by proponents, manifest in several indicators. These include: poverty eradication or reduction; gender equality; economic growth with creation of jobs and promotion of strong economies; better standard of education and healthcare particularly in relation to water quality and better sanitation; and resilience in terms of the effects of climate change among other indicators (Olsen and Fenhann, 2008; Prüss-Üstün, 2008; David *et al*., 2013). Accordingly, sustainability has become very popular and engaged the attention of policy makers and implementers, as well as industry players across all disciplines. Indeed, Bell and Morse (2008) note that sustainability has become central to development discourse in a manner that only few development initiatives or research proposals are able to secure sponsorship or funding without the words "sustainability" or "sustainable" appearing in such proposals to funding agencies.

Although various disciplines have adopted and are adopting the principles of sustainability, the attention on sustainability and its application within the built environment continue to intensify. This is because of the crucial role the built environment plays in the destruction of natural, human and social capital (Holdsworth & Sandri, 2014). For example, it is estimated that buildings and the building industry consume 32% of the world's resources including between 40-50% of energy and up to 16% of the water used annually worldwide (IyerRaniga *et al*., 2010; Holdsworth & Sandri, 2014). Further, the building industry produces about 40% of waste that goes to landfill and accounts for 40% of air emissions (Holdsworth & Sandri, 2014). This implies that the intensification of the application of sustainability principles within the built environment is justified and there is a need for mechanisms for their implementation. At the heart of any strategy to implement or promote sustainability principles within the built environment is a well-crafted sustainable built environment education curriculum for stakeholders, such as built environment students and professionals (Iyer-Raniga *et al*., 2010). This is to equip graduates from higher education, professionals and other stakeholders to use and manage the built environment sustainably.

However, such a sustainable built environment education curriculum requires a suitable framework given sustainability education is unique, differing immensely from other, more conventional modes of education (Holdsworth & Sandri, 2014). This is compounded by the fact that knowledge obtained from sustainability science and related fields to support transitions to sustainability remains a critical theoretical and empirical question for basic and applied research (Miller *et al*., 2014). Although several studies (Iyer-Raniga *et al*., 2010; Iyer-Raniga and Andamon, 2012; Holdsworth & Sandri, 2014; Altomonte *et al*., 2014; Conte, 2016) have examined the link between sustainability and the built environment education in an attempt to prescribe a sustainable built environment education curriculum. The development of comprehensive framework for the incorporation of sustainability in the built environment education remains elusive.

Consequently, this study aims to contribute to the development of a comprehensive framework to incorporate sustainability into the built environment education curriculum. The concept of Sustainable Development within the Construction Industry is explored and literature relating to the importance and challenges of embedding sustainability in built environment education is explored before a series of four case studies are undertaken appraising existing RICS accredited QS degree programmes to appraise levels of sustainability inclusion within the curriculum. From this analysis, a modular framework for integration of sustainability education in built environment programmes is proposed.

## SUSTAINABLE DEVELOPMENT AND THE CONSTRUCTION INDUSTRY

Sustainability and sustainable development (SD) are inextricably linked. Environmental, industrial and manmade disasters continue to trouble human existence. It is generally accepted that some natural disasters caused by forces of nature are inevitable. However, proponents in this field believe that we must do something about manmade and environmental hazards such as the threat of global warming caused by human action or inaction (Spence & Mulligan, 1995; Azapagic, Perdan & Shallcross, 2005; IPCC, 2014; Yilmaz & Bakis, 2015; Zaid, Jones & Holgate, 2017). Apart from being the morally acceptable thing to do, the current generation as the custodian of the built environment owe it to future generations to preserve and maintain the natural habitat. This was the main theme in the report of the World Commission on Environment and Development (Brundtland, 1987), and several global events thereafter have reinforced the idea of SD (Ekundayo *et al.*, 2011).

According to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5), global warming otherwise referred to as climate change is caused by the emission of greenhouse gases (GHGs) mainly carbon dioxide (IPCC, 2014). There are different aspects to sustainability (Son *et al*., 2011; Gan *et al*., 2015; Yilmaz & Bakis, 2015), but the fundamental principle is for all development activities to be both less resourceintensive and less environmentally damaging (Spence & Mulligan, 1995; Sev, 2009). The crucial elements often referred to as the triple bottom line of SD are society, environment and economy. While the topic of sustainability remains highly contested, it is evident that the earth finite resources must be managed effectively whilst at the same time reducing GHG emissions accumulating in the biosphere. This is necessary for the survival of the earth and its current and future occupants.

As mentioned by Spence and Mulligan (1995), the rapid depletion of the world's finite resources and the build-up of GHGs in the habitat leading to global threat of climate change implies that the construction industry has a vital role to play in achieving a sustainable future. Infrastructure and its associated developments are key to economic growth and global competitiveness. The construction industry and its extensive workforce help to build resilient infrastructures and sustainable (built) environments that we all rely on. This multibillion pound industry is however one of the largest exploiters of natural resources and a major producer of GHGs such as embodied and operational carbon. Buildings and infrastructures make use of raw materials produced from mineral and natural resources. The extraction, production, transportation and recycling or disposal of these raw materials, are energy intensive. In addition, the buildings lifecycle, from cradle to grave i.e. from construction to demolition, have negative impacts on the environment (Tan *et al*., 2011).

According to Yilmaz & Bakis (2015), buildings use 45% of world energy and 50% of water. In a similar study, Dixon (2010) highlights the environmental hazards caused by buildings such as 23% of air pollution, 50% of greenhouse gas production, 40% of water pollution and 40% of solid waste in cities. As well as buildings contributing to 50% of raw material consumption, the waste produced by the construction industry varies between 15 and 50% as reported by Sev (2009). Clearly, the construction industry is resource-intensive and a major polluter of both built and natural environments such that sustainability is now a key concept in development thinking at all levels. This led to the assertion by Sev (2009) that the significance of the construction industry in achieving economic growth, social progress and effective protection of both built and natural environments cannot be overstated.

## IMPORTANCE AND CHALLENGES OF EMBEDDING SUSTAINABILITY IN BUILT ENVIRONMENT EDUCATION

The purpose of this section are twofold, that is, to review the importance and challenges of embedding SD in built environment (BE) education. The construction industry has a vital role to contribute to SD as the major energy, mineral and natural resources consumer. Construction industry is responsible for the development of nations and buildings as well as their associated infrastructures have numerous economic, social and environmental impacts. According to Son *et al*. (2011) the construction sector has the greatest impact on national economies and the environment. Structures can last for several decades and in some cases centuries. However, sustainable construction is a notion that cannot materialise without a solid understanding and knowledge of sustainability concepts.

Whilst the construction industry generates many benefits to the built environment and society at large, the pressure of its activities on the natural habitat is alarming. Depletion of the biological and mineral resources many of which are non-renewable and deterioration of the physical environment such as loss of soil, forests and agricultural land, as well as increasing air pollution, global temperature and sea level rise are only a few examples. The ambitious targets set by the UK Government for all new domestic and commercial buildings to be zero carbon by 2016 and 2020 respectively is a step in the right direction to curb the irreversible damage being done (Zaid *et al.*, 2017). Consequently, we cannot leave this to our industry thinkers and policy-makers alone to proffer solutions. Perhaps, we should focus more on BE stakeholders' particularly higher education institutions (HEIs) that educate construction industry professionals. The huge contribution that HEIs can make in achieving SD underlines the importance of embedding sustainability in BE education. Whilst Government initiatives are having a positive impact, it is believed that HEIs are imperative in driving the sustainability agenda forward (Cotgrave & Kokkarinen, 2010; Sutrisna & Rowe, 2012; Fukukawa *et al*., 2013; Brennan & Cotgrave, 2014).

HEIs have been striving to incorporate sustainability into their BE curriculum in order to maintain the currency of their programmes. This is reinforced by the need for the education sector to ensure that construction graduates are fit for purpose and able to lead the design, construction and management of sustainable structures (Sutrisna & Rowe, 2012). BE professionals make decisions and engage in activities that can lead to physical alteration of the natural environment. This has led to the surge in interest in sustainability and calls for BE schools to educate economically aware, socially responsible and environmentally conscious graduates. Although this has been a topic of discussion for much longer, for example the UN declaration for the decade of education for sustainable development (ESD) 2005 to 2014 (UN, 2002), the development of a framework to embed sustainability into BE curriculum is long overdue.

Despite the growing importance of ESD in HEIs around the world, its implementation in the construction industry and BE sector remains a challenge (Brennan & Cotgrave, 2014). In a study carried out by Fukukawa *et al*. (2013), barriers to the development of an SD curriculum for degree programmes were identified. These include time constraints on the part of teaching staff along with their perceived lack of expertise about SD, the need for a coherent strategy at the school level, attitudes towards ESD and lack of university initiatives of this kind. Earlier, Cotgrave & Kokkarinen (2010) classified the barriers into organisation and funding of UK universities, academic indifference and approach to teaching and assessment, and lack of communication between industry and academia. While the barriers are being addressed by HEIs that promote ESD, there is need for a framework to enhance the creation, implementation and delivery of ESD programmes in BE schools. Cotgrave & Kokkarinen (2010) describe this as a sustainability literate construction curriculum. The proposed framework will address the perceived lack of action from HEIs and will ensure that sustainability literacy is fully realised in practice.

## PREVIOUS RESEARCH ON SUSTAINABILITY EDUCATION

Sustainability is often perceived as a political propaganda inspired by environmental consciousness and driven by socio-economic factors. Yet, the importance of ESD in the construction curriculum is widely accepted. Sustainable development, green supply chain management and sustainable construction are just a few of the lexicons bandied around in the construction industry and other sectors as a means to an end, a way to achieve sustainability. As such, different studies over the years have examined the nomenclature of sustainability, but limited research exist on how this concept can be integrated into BE curriculum (Cotgrave & Kokkarinen, 2010; Sutrisna & Rowe, 2012; Fukukawa *et al*., 2013).

A recent study by Tan *et al*. (2017) investigated the extent in which sustainable development is embedded in the construction related curriculum based on the perception of quantity surveying students. The findings from this study and a review of extant literature revealed that students have basic/limited knowledge of sustainability despite the high importance placed on sustainability education from different directions. This supports findings from previous studies, which suggest that the level of inclusion of sustainability in the curricula appears to be low (Azapagie *et al*., 2005; Cotgrave & Alkhaddar, 2006; Perera & Pearson, 2011; Ekundayo *et al*., 2011). In the light of the above, it was suggested that there is the need for a framework for embedding sustainability education in the curriculum.

Fukukawa *et al*. (2013) examines the implementation of ESD within a business school through a case study approach. Similarly, Ekundayo *et al*. (2011) attempted to map sustainability education to construction related curricula using a case study of quantity surveying degree programme. Consequently, this led to the development of a sustainability framework relevant to quantity surveying degree programme. The framework groups the sustainability-related knowledge areas relevant to QS education into six main categories (such as background knowledge and concept, policies and regulations, environmental issues, social issues, economic issues, technology and innovation) with several subcategories. It is on this basis that this study becomes imperative with a view to develop a framework for embedding sustainability education into BE curriculum.

Sustainability is a global issue and human building activity has huge ramifications for current and future generations. A truly sustainable project, which is economically viable, socially acceptable and environmentally friendly, requires a concerted effort. Construction professionals such as Architects, Quantity Surveyors and Project Managers, educated in BE schools, are tasked with the responsibilities of designing, costing, constructing and managing these structures. BE professionals thus have an important role to play in creating a healthy built environment, juxtaposed within the natural habitat, which are affordable and accessible. To this end, this research would be of great value and would eventually lead to the development of a future paradigm for BE curriculum design.

## RESEARCH METHODOLOGY

Previous research established that there is indeed a discourse and a gap on how the sustainability issues are taught in built environment programmes in the UK. The current research sought to develop a framework that satisfies the aspirations of the various stakeholders (i.e. students, universities, professional bodies, industry, etc.). The main research instrument used to achieve this include case studies. Detailed case studies of four universities, which the authors have identified as A, B, C & D were used to generate a sustainability mapping for the study.

The case studies include examination of four RICS accredited QS degree programmes. The curricula of these programmes (module specifications, module handbooks, programme specifications) were analysed to establish the common thread in all the programmes in the four universities. The ensuing outcome of the analysis was then verified for accuracy and consistency with programme directors and module tutors responsible for delivery of these programmes and with some recommended industry liaison board members of the various universities involved.

Case study uses a variety of data collection techniques, such as questionnaires, observations, interviews and published documentary information etc. (Yin, 1994). The advantage of using this method of data collection is that it takes into account the numerous literatures available by narrowing down the scope in order to seek understanding of a particular phenomenon, which is the aim of this study. The case study will be analysed from quantitative (i.e. descriptive analysis) and theoretical point of view to create the sustainability mapping. The latter involves searching-out of underlying themes in the materials being analysed and making critical evaluation of the extracted themes (Bryman, 2008).

### Case Studies

The four case studies selected were leading QS honours degree programmes in the UK all accredited by the RICS. The QS undergraduate programme is either studied as BSc (Hons) Full Time for 3 years full-time or 4 years sandwich. In Year 1, (otherwise known as Level 4), studies focus on the principles of knowledge on which quantity surveying is based including undertaking a UK-based residential field study visit. Year 2 (or Level 5) concentrates on the role of the Quantity Surveyor in practice and prepares students for work in the optional placement year. Students are strongly encouraged to undertake a placement year as it gives them the opportunity to put into practice what they have learnt in the first 2 years of their study before progressing onto the final year. In Final Year (otherwise referred to as Level 6), the broader role of the Quantity Surveyor is investigated whilst further developing relevant academic skills and undertaking an optional European-based residential study visit.

These four universities are the major providers of QS and construction related programmes and training in the UK, therefore, their programmes have to be sound, up to date and at the fore front of knowledge. This is critical if they are to maintain their absolute relevance well into the future and to keep attracting applicants from within the UK and worldwide. The adequate inclusion of sustainability education into their curriculum is of paramount importance to produce graduates confident of taking care of the built and natural environments. It is therefore necessary to examine the extent of coverage of sustainability within their QS curriculum, which is the focus of this study.

**Sustainability Mapping**

Ekundayo *et al*. (2011) developed a sustainability framework (see figure 1), which identifies the knowledge areas relevant to the QS degree programme and the profession. The framework, developed based on current and future roles of the professional quantity surveyor as informed by the sustainability agenda, categorises the sustainability-related knowledge areas relevant to QS education into 6 main categories (high level categories) with several subcategories (low level categories). The curricula (module specifications, module handbooks, programme specifications) of the four universities were mapped against the sustainability framework to evaluate the extent of coverage of sustainability education in these QS degree programmes.

**SUSTAINABILITY FRAMEWORK**

| | | | | | | |
|---|---|---|---|---|---|---|
| HIGH LEVEL CATEGORIES | CATEGORY A - BACKGROUND KNOWLEDGE AND CONCEPT | CATEGORY B - POLICIES AND REGULATIONS | CATEGORY C - ENVIRONMENTAL ISSUES | CATEGORY D - SOCIAL ISSUES | CATEGORY E - ECONOMIC ISSUES | CATEGORY F - TECHNOLOGY AND INNOVATION |
| LOW LEVEL CATEGORIES | Sustainable development overview and principles<br>Climate change and global warming issues<br>Impact of the construction industry on the environment<br>Sustainable construction concept<br>Role of QS in sustainable development | Changes to Building regulation, e.g. Part L (energy efficiency) and Part F (means of ventilation)<br>Code for Sustainable Homes<br>Energy Performance Certificate (EPC)<br>The Kyoto protocol<br>Relevant EU Directives such as the EU climate policy, EU ETS, etc<br>Climate Change Act<br>Sustainable Construction Strategy<br>Sustainable Procurement Action Plan | Protecting and enhancing the built and natural environments<br>Environmental Impact Assessments (EIA)<br>Environmental Management Systems: ISO 14001<br>Environmental Assessment Methods: BREEAM, LEED, Green Star<br>Reducing energy consumption, that is, emitted and embodied<br>Reducing greenhouse emission such as methane, carbon, nitrous oxide and refrigerant gases<br>Carbon Agenda (Carbon footprinting, Zero Carbon, Retrofit)<br>Waste reduction principles (recycling, reduction, reuse, effective design)<br>Brownfield development<br>Natural resources, renewable and non-renewable materials<br>Water usage and Sustainable Transportation Plan | Corporate Social Responsibility (CSR)<br>Ethical issues such as ethical sourcing of materials and labour, for instance<br>Equity and social justice<br>Community development and social inclusion<br>Health & safety<br>Employment, training and education<br>Social assessment methods (e.g. Design Quality Indicators, KPIs and benchmarking, etc)<br>Cost Benefit Analysis (i.e. impact of human factors on the community) | Cost planning and management<br>Value management or engineering (cost of alternative materials and designs)<br>Sustainable procurement strategies<br>Feasibility studies<br>Whole-life appraisal/ Life cycle costing<br>Financial incentives (such as subsidies, climate change level, aggregate tax, carbon credit, Brownfield land tax, etc) | Renewable energy technologies (Photovoltaic, Wind Turbine, Geothermal, Biomass, etc)<br>Green Building Materials<br>Rain water harvesting and Grey water collection systems<br>Professional and management software packages such as BIM, etc<br>Modern methods of construction: offsite production, use of precast material, lean construction, etc<br>Passive design methods such as day lighting, intelligent facades, carbon storage and offsetting, etc<br>Supply chain management<br>Effective information control and management (using e-business) |

Figure 1. Sustainability framework relevant to QS degree programme (Ekundayo *et al*., 2011)

## RESEARCH RESULTS

The sustainability mapping of QS degree programmes, shown in figure 2, reflects the overall coverage of depth and breadth of coverage of the sustainability issues within the four case studies. The outcomes of the mapping illustrate how the sustainability issues are embedded in the modules, specifications and the handbooks of the four case studies. As can be seen from figure 2, all the pre-determined sustainability issues are present in all four universities, however, how these attributes have been embedded are inconsistent across the four case studies, and more alarmingly attainment often achieved in isolation, for instance through one specific module. Rather than through a more considered and holistic curriculum design that ensures sustainability and sustainable development are robustly addressed in contexts relevant to the profession.

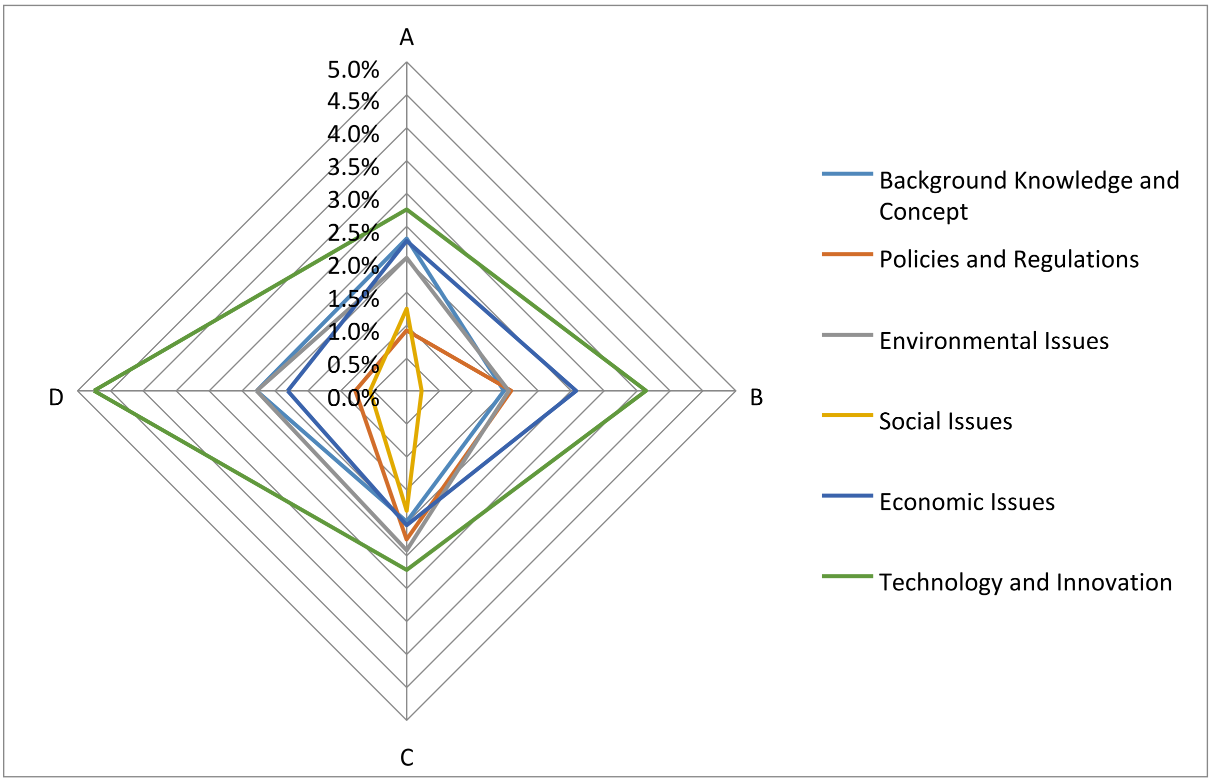


Figure 2. Sustainability mapping (high level categories) of QS degree programmes

## DISCUSSION AND CONCLUSION

The quantitative results illustrate that the curriculum, at least in these four institutions, emphasises technological and innovation aspects rather than broader sustainable development issues and more than any other categories in the framework. While this is interesting, it is not so surprising as subjects such as renewable energy technology, BIM, green supply chain management and passive design methods among other things have become very popular and central to the sustainability discourse. This finding is interesting because more than often, sustainability-related literature (such as Spence & Mulligan, 1995; Azapagic *et al*., 2005; IPCC, 2014; Yilmaz & Bakis, 2015; Zaid *et al.*, 2017) accord greater emphasis to the background knowledge and concept subject areas as revealed in the literature.

As the mapping was done against QS degree programmes, it would also have been expected that economic issues such as cost planning, value management, sustainable procurement strategies, and whole-life appraisal be covered in the curriculum at a higher level than any other sustainability issues in the framework. Nevertheless, this more or less emphasises the role of technology and innovation in sustainability implementation. Also, technology is now often use to enhance the role of a quantity surveyor. The somewhat disturbing part of the findings however is that economic issues are covered at a relatively low level in some institutions, and this cannot be right. Further investigation is thus required in this regard.

The coverage of environmental issues and policies and regulations in the curriculum is plausible in the light of previous work and perspectives of proponents in the field such as Bell and Morse, 2008; Olsen and Fenhann, 2008; PrÜss-ÜstÜn, 2008 and David *et al*., 2013.
However, the very low coverage and emphasis on social issues is not so surprising.

Literature that discuss issues such as corporate social responsibility, ethical issues, equity and social justice, cost benefit analysis and social assessment methods as an important part in the sustainability discourse are rare. Consequently, this is reflected in the very low (and in some cases non-existence) level of social issues in the QS curriculum.

Generally, the above findings support results from previous studies like Perera & Pearson (2011) and Tan *et al*. (2017). Sustainability may be evident across only 0.5-4.5% of the curricula of Quantity Surveying programmes, at least in these four institutions, and incorporated at a basic level only. This is in spite of the need and relentless call for a framework for embedding sustainability education in the curriculum as the literature review suggested (Azapagie *et al*., 2005; Cotgrave & Alkhaddar, 2006; Ekundayo *et al*., 2011).

Professional institutions are increasingly placing more emphasis on broader issues of sustainable development, and there have been explicit requirements of mapping BE curriculum against addressing sustainable development issues. As such sustainable development should be seen in such neat categories of competence areas as identified in the sustainability framework. Understanding and addressing sustainable development is, however, a good problem. Thus, this calls for multi-disciplinary and often innovative ways of teaching and learning the 'subject'. There needs to be some acknowledgement of this, and also progress made especially in encouraging multidisciplinary approaches to education for sustainable development. This research agrees with previous work (e.g. Ekundayo *et al*., 2011) that a concerted effort across the disciplines is needed in order to integrate sustainability issues into BE programmes. Including the views and input from other stakeholders such as students, professional bodies and industry practitioners in this regard is also of paramount importance.

Findings from the literature review and relevant work previously discussed, as well as this study, indicate that there are challenges to embedding sustainability in BE education. This study is part of a larger research within the education for sustainable development, which aims at diffusing sustainability into the curricula of BE programmes in UK universities. While this research focussed mainly on mapping the inclusion of sustainability within the quantity surveying curriculum, it is evident further investigation is now required to appraise the inclusion of sustainability within other BE degree programmes. Furthermore, whilst the study identifies the breadth and depth of sustainability-related materials within existing curriculum, future research is needed to develop a modular framework for further integration of sustainability education in BE programmes. The framework could serve as an evaluation and a benchmarking tool for those who engage in developing the content of BE degree programmes, policy makers and implementers, as well as industry players across all disciplines.

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# Analysis of the drivers and benefits of BIM incorporation into quantity surveying profession

## Academia and students' perspectives

Solomon Olusola Babatunde
*Department of Quantity Surveying, Obafemi Awolowo University, Ile-Ife, Nigeria*

Damilola Ekundayo
*School of the Built Environment, University of Salford, Greater Manchester, UK, and*

Olubola Babalola and Jumoke Aduramigba Jimoh
*Department of Quantity Surveying, Obafemi Awolowo University, Ile-Ife, Nigeria*

**Abstract**

**Purpose** – Building information modeling (BIM) inclusion in education pedagogy is crucial in preparing skilled graduates for employment in the construction industry. Against this backdrop, studies on BIM education abound in architecture, engineering and construction (AEC) programmes in higher education institutions (HEIs). However, there are limited empirical studies on BIM potentials in the quantity surveying (QS) profession in HEIs, particularly in developing countries. The purpose of this study is to identify and assess the BIM drivers and benefits as important to the QS profession using an empirical approach.

**Design/methodology/approach** – A comprehensive literature review was conducted to identify the BIM drivers and benefits in relation to the QS profession, which was used to design a questionnaire. To capture a broad perception, a questionnaire survey was carried out which targeted the academia and final year undergraduate students from two selected universities offering QS honour degree programmes in Nigeria. Data collected were analysed using mean score, standard deviation and Mann–Whitney test.

**Findings** – The study identified 12 BIM drivers in relation to the QS profession and the analysis of the ranking revealed that almost all the identified BIM drivers are considered by respondents as important. The study further identified 14 BIM benefits and the analysis of the ranking indicated that all the identified BIM benefits are considered as important. The results of the Mann–Whitney test indicated a slight statistically significant difference, particularly in one of the selected universities on the ranking of the BIM drivers and benefits as important to the QS profession.

**Practical implication** – The findings of the study provide empirical evidence on the current perceptions of the drivers and benefits of BIM to QS academia and students as they explore the concept for the advancement of QS profession.

**Originality/value** – This study would provide practical insights to use BIM for QS practice. Also, this study would contribute to improving the QS graduates and professional quantity surveyors understanding of the BIM knowledge applicable to QS profession.

**Keywords** Nigeria, BIM, Higher education institutions, Drivers, Quantity surveying

**Paper type** Research paper

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## Introduction

Building information modelling (BIM) has been a growing trend in the construction industry, although BIM in some forms has existed over 20 years. Liu and Hatipkarasulu (2014) described BIM as an emerging trend in the construction industry and a much-desired skill for Architecture, Engineering and Construction (AEC) students as they are preparing for their professional careers. Lee *et al.* (2013) described BIM as a process of creating an intelligent virtual model which integrates the project data from design to construction and operation. Thus, it facilitates project documentation, project quantification and estimation. Lee and Dossick (2012) asserted that BIM takes a major role during the design and construction phases of a project, and there is a growing focus on the use of BIM for operations and maintenance. For example, Young *et al.* (2009) found that about 50 per cent of the construction industry in the USA are using BIM and its adoption will increase the positive returns from the use of BIM. BIM has become a central issue in the construction industry and many researchers currently explore the potential of BIM as a new ICT to improve productivity in the construction industry (Kim, 2012).

McGraw Hill (2010) reported that BIM inclusion in education pedagogy is crucial in preparing skilled graduates for employment in the industry. This is affirmed by Han and Bedrick (2015) that BIM adoption will suffer without its incorporation into education. Executing a BIM project requires new strands of expertise for all disciplines compared to more traditional projects (Puolitaival and Forsythe, 2016). This creates an obvious need for AEC students to know more about BIM to be knowledgeable in an arising area of relevance to both modern projects and the profession. Therefore, the incorporation of BIM in higher education is not only served the increasing demand for BIM professionals but also produce new opportunities for students in their professional careers in the form of their ability to deal with new occupational challenges with high efficiency achieved by applying BIM (Wong *et al.*, 2011).

The studies on BIM education abound in AEC programmes in higher education institutions (HEIs) (Taylor *et al.*, 2008; Clevenger *et al.*, 2010; Lee and Dossick, 2012; Panuwatwanich *et al.*, 2013; Sacks and Pikas, 2013; Shelbourn *et al.*, 2017). Other relevant studies include Olawumi and Chan (2018) evaluated the perceived benefits of integrating BIM and sustainability practices in construction projects and authors found that the ability to enhance overall project quality and efficiency and improve the ability to simulate building performances are the most important benefits. Wong and Yew (2017) investigated barriers to implementing BIM in quantity surveying firms in Sarawak, East Malaysia, and the authors found that high initial cost, lack of training and knowledge as the top ranked barriers. Ghaffarianhoseini *et al.* (2017) examined current benefits associated with the use of BIM and found that BIM definitive benefits have not been fully capitalized by industry stakeholders. Ali *et al.* (2015) developed BIM educational framework for quantity surveying students in Malaysia. In Nigeria, few studies have been conducted on the issues of BIM implementation. For instance, Abdullahi *et al.* (2011) assessed the application of BIM in the Nigerian construction industry, and the authors found a low level of knowledge of BIM in the Nigerian construction industry. Abubakar *et al.* (2013) examined the readiness of building design firms to adopt BIM technologies and the study showed that the design firms are very ready to implement BIM technologies in their practices. Abubakar *et al.* (2014) investigated the level of BIM awareness and barriers to its adoption in the Nigerian construction industry from the contractors' perspectives. In spite of these previous studies, there is a limited occurrence of research into BIM potentials in the QS profession in HEIs (Fung *et al.*, 2014). Also, prior studies that considered BIM drivers and benefits into QS profession from perspectives of academia and students are not very common. Therefore, this study was guided by the following derived objectives:

- identify the BIM drivers and benefits in relation to QS profession; and
- assess the perceptions of the academic and students on the ranking of identified BIM drivers and benefits in the order of perceived importance

It is anticipated that this study would contribute to improving the QS graduates and professional quantity surveyors understanding of the BIM knowledge applicable to QS profession. Hence, this study would connect QS graduates more effectively to the industry.

## Literature review

### *Building information modelling drivers and benefits relating to quantity surveying profession*

Quantity surveying (QS) is a profession that is well established in the British Commonwealth as being responsible for the management of cost and contracts in the construction industry (Pheng and Ming, 1997; Bowen *et al.*, 2008; Ling and Chan, 2008). The profession is also known as construction economics in some European countries and in other parts of the world. Further, the profession is term cost engineering in the North and South America, China and some parts of Europe (Pathirage and Amaratunga, 2006; Smith, 2009). Due to the emergence of BIM, Ashworth and Hogg (2007) asserted that the traditional role of quantity surveyors, which include estimating and cost planning, procurement advice, measurement, preparation of bills of quantities among others could be more effectively and efficiently achieved using BIM. This is affirmed by Olatunji *et al.* (2010) and Zhou *et al.* (2012) that BIM has the potential to remove mundane elements of traditional quantity surveying, such as taking off and the production of bills of quantities, by automating or assisting in these tasks removing human error, increasing efficiency and promoting collaboration. RICS (2011) reported that BIM enables the quantity surveyor to produce the bill of quantities in hours/days rather than weeks/months. This is supported by Whatmore (2012) that one of the key benefits of BIM is that it allows quantity surveyor to focus more on other value-adding services for their projects-rather than spending up to 80 per cent of their time measuring quantities.

It has been recognized that BIM has a high potential to inspire every aspect of the quantity surveying profession (Pittard, 2012). Hence, the quantity surveyors should fully embrace BIM to increase the cost-effectiveness and value of construction processes. Olatunji *et al.* (2010) advocated the need for the full adoption of BIM across all disciplines. Therefore, it is important to understand the drivers for adopting BIM in quantity surveying practice. Thus, Table I indicates the selected drivers for BIM adoption in the quantity surveying profession.

It is important for the quantity surveyors to appreciate BIM, understand its potential and develop effective processes to integrate BIM into their current practices (Cartlidge, 2011). This is supported by Wu *et al.* (2014) that quantity surveyors should aware of the opportunities that BIM could bring in relation to their current and future roles. Therefore, Table II presents the selected BIM benefits relating to the quantity surveying profession.

| S/n | BIM drivers | Reference |
|---|---|---|
| 1 | Desire for innovation to remain competitive | Ruikar *et al.*, 2005; Eadie *et al.*, 2013 |
| 2 | Improving the capacity to provide whole life value to client | Azhar, 2011; Deutsch, 2011; Eadie *et al.*, 2013 |
| 3 | Availability of trained staff (from academia and industry) using BIM to teach the students | Macdonald, 2012; Badrinath *et al.*, 2016 |
| 4 | BIM software availability and affordability | Macdonald, 2012; Eadie *et al.*, 2013 |
| 5 | Enabling environment-provision of IT infrastructure | Oladapo, 2007 |
| 6 | Cooperation and commitment of professional bodies to its implementation | Oladapo, 2007; Becerik-Gerber *et al.*, 2011 |
| 7 | Government support through legislation | Efficiency and Reform Group, 2011; buildingSMART Australasia, 2012; Eadie *et al.*, 2013 |
| 8 | Awareness of BIM tangible benefits | National Building Specification (NBS) (2012) |
| 9 | Strong support from university management and industry | Becerik-Gerber *et al.*, 2011; Badrinath *et al.*, 2016 |
| 10 | Accreditation standards and requirements to guide the implementation of BIM within the curriculum | Becerik-Gerber *et al.*, 2011; Macdonald, 2012; Panuwatwanich *et al.*, 2013; Badrinath *et al.*, 2016; |
| 11 | Awareness of the IT among quantity surveyors | Oladapo, 2007 |
| 12 | Clients' demand for the use BIM in their project | Liu *et al.*, 2010; Eadie *et al.*, 2013 |

**Table I.** BIM drivers as important to quantity surveying profession

| S/n | BIM benefits | Reference |
|---|---|---|
| 1 | BIM provides fast, effective and efficient quantity take-off and cost estimation | Aouad *et al.*, 2007; Sabol, 2008; Cartlidge, 2011; Eastman *et al.*, 2011; Zhou *et al.*, 2012; Choi *et al.*, 2014; Stanley and Thurnell, 2014 |
| 2 | Produce reliable and accurate quantities as well as competitive cost estimates | Azhar, 2011; Deutsch, 2011; Stanley and Thurnell, 2014; Thurairajah and Goucher, 2013 |
| 3 | It updates cost plans with more details as design is developed | Sylvester and Dietrich, 2010 |
| 4 | It generates accurate cost estimates for various design alternatives | Eadie *et al.*, 2013; Thurairajah and Goucher, 2013 |
| 5 | Time savings in the preparation of estimating costs | Nassar, 2012; Bryde *et al.*, 2013; Eadie *et al.*, 2013; Wu *et al.*, 2014 |
| 6 | Reduction of requests for information | Smith, 2014; Franco *et al.*, 2015 |
| 7 | Clash detection to reduce design errors | Eadie *et al.*, 2013; Fung *et al.*, 2014; Franco *et al.*, 2015 |
| 8 | Simplify cost checking and update | Sylvester and Dietrich, 2010; Fung *et al.*, 2014 |
| 9 | Improved visualization for better understanding of designs for measurement and minimize omissions | Sylvester and Dietrich, 2010; Thurairajah and Goucher, 2013 |
| 10 | Automatic quantification of BOQs preparation | Aouad *et al.*, 2007; Autodesk, 2012; Zhou *et al.*, 2012 |
| 11 | Data storage in central coordinated model | Sylvester and Dietrich, 2010; Franco *et al.*, 2015 |
| 12 | Enhance communication and collaboration amongst team members | Shen and Issa, 2010; Efficiency and Reform Group, 2011; Ahmad *et al.*, 2012; Zhou *et al.*, 2012; Bryde *et al.*, 2013; Smith, 2014; Franco *et al.*, 2015 |
| 13 | Improve cost database management which reduces loss of information | Shen and Issa, 2010; Bryde *et al.*, 2013; Fung *et al.*, 2014 |
| 14 | Rapid identification of design changes | Azhar, 2011; Fung *et al.*, 2014 |

**Table II.** BIM benefits relating to quantity surveying profession

Existing studies have highlighted the reasons for integrating BIM into the QS profession (Sabol, 2008; Eastman *et al.*, 2011). For instance, Thomas (2010) identified some reasons as follows:

- 30 per cent of the projects do not meet the original programme or budget;
- 37 per cent of materials used in construction become waste;
- 10 per cent of the cost of a project is typically due to change orders; and
- 38 per cent of carbon emissions are from buildings not cars.

Sabol (2008) described that during conventional (e.g. manual) project development, accurate, actionable costing information has been difficult to define during preliminary project phases. This process is prone to human error and tends to propagate inaccuracies. The quantification is time intensive, which requires 50 per cent to 80 per cent of a cost estimator's time on a project. However, the development of early cost estimates is widely facilitated by BIM (Sabol, 2008). This is supported by Nagalingam *et al.* (2013) that BIM reduces the resources needed for a construction project and costs are saved on the reduction of resources. This is affirmed by Gier (2015) that BIM is a helpful teaching tool for construction estimation, quantity take-off and highly contribute to design comprehension skills and understanding of construction materials, methods and processes.

## Research methodology

The target population for this study comprised the academic staff and students in final year at undergraduate level from two selected public federal universities in Southwestern Nigeria to include Obafemi Awolowo University, Ile-Ife, and the Federal University of Technology, Akure offering quantity surveying honours degree programmes. The basis for selecting only this group (i.e. academics and students), for example, Perera *et al.* (2013) identified the key stakeholders with influence on QS education and practice as academics, industry and professional bodies. Academic stakeholders were deliberately selected for this study due to their accurate knowledge of QS programme and students in their final year were chosen because of their appreciation of the QS programme learning outcomes. Academics also play a significant role in designing and maintaining the curriculum used to teach QS students (Perera *et al.*, 2017). This study established the drivers and benefits of BIM incorporation into quantity surveying by evaluating academic and student perceptions. A similar approach was adopted in a construction-related research conducted (Ekundayo *et al.*, 2011; Tan *et al.*, 2017). In addition, this approached was similar to previous studies on BIM education. For instance, Clevenger *et al.* (2010) administered questionnaires to students when exploring the incorporation of BIM into the construction management curriculum. Hedayati *et al.* (2015) surveyed both the students and lecturers when exploring the obstacles to implementing BIM in the educational system. Abbas *et al.* (2016) sampled only academic staff when exploring the current state of BIM in the construction management programme at the engineering universities in Pakistan.

The rationales for selecting these two universities are as follows:

(1) The universities are the leading universities offering quantity surveying honours degree programmes in Southwestern Nigeria.

(2) Their QS programmes are fully accredited by both the National Universities Commission and the Quantity Surveyors Registration Board of Nigeria.

(3) They have the highest number of quantity surveying students' enrolment at undergraduate study. This study adopted a literature review and questionnaire survey, which are detailed as follows.

*Literature review*
An extensive literature review was conducted to identify the BIM drivers and benefits as important to the QS profession. These were identified from the significant literature. The outcome of the literature review produced 12 BIM drivers and 14 BIM benefits relating to the QS profession (see Tables I and II for details). These were used to design the questionnaire survey. This is, therefore, form the basis of inquiry for the data collection and analysis.

*Questionnaire survey*
The data for the study were collected through the administration of questionnaires to both the academic staff and final year students from the two selected universities to include quantity surveying department at Obafemi Awolowo University (OAU), Ile-Ife and quantity surveying department at the Federal University of Technology Akure (FUTA). The total number of academic staff in the quantity surveying department from the two universities is 39 academic staff comprised 13 academic staff at OAU and 26 academic staff at FUTA. Due to the small sample size of the academic staff from both universities, the entire 39 academic staff were sampled. Out of which 27 completed responses were received comprising ten responses from OAU and 17 responses from FUTA. Similarly, in 2016/2017 academic session, the total number of final year undergraduate students in the quantity surveying department from the two universities was 161 students comprised 62 students at OAU and 99 students at FUTA. A total of 81 students were randomly selected to include 31 students at OAU and 50 students at FUTA. The survey received 28 completed responses from OAU and 45 completed responses from FUTA. This resulting in a total of 73 fully completed responses from students. The high response rate obtained in this study was due to the fact that the questionnaires were distributed face-to-face (i.e. hand delivery) and follow-up through telephone contacts and text messages are carried out to remind the respondents to complete the questionnaires.

The questionnaire designed for the study was structured and multiple-choice type. The questions were asked on a five-point Likert scale with 5 being the highest of the rating. A reliability test using Statistical Package for the Social Sciences (SPSS) was conducted. The result indicated the reliability coefficient values of Cronbach's alpha 0.901 and 0.890 for the BIM drivers and benefits, respectively. These Cronbach's alpha values signifying that the questionnaire used for the study is reliable and indicates evidence of good internal consistency. This is corroborated by George and Mallery (2003) that Cronbach's alpha value of greater than 0.6 is considered acceptable. This is affirmed by Pallant (2007, 2010) that the value for Cronbach's alpha should be higher than 0.7 for the scale to be reliable. In this study, both the descriptive and inferential statistics were conducted for the analysis. The descriptive statistics techniques used include the mean score and standard deviation. The mean score was used for the ranking of identified BIM drivers and benefits relating to quantity surveying practice. Also, the inferential statistics used was the Mann–Whitney test. This is supported by Field and Miles (2012), and Field (2013), which stated that the Mann–Whitney test was based on ranked data. In addition, Fellows and Liu (2008) asserted that the Mann–Whitney test is used when there are two samples. Therefore, the Mann–Whitney test was conducted in this study to determine whether there is a statistically significant difference in the ranking of the identified BIM drivers and benefits between the academic staff and students. The Mann–Whitney test was undertaken at a significance level

**Table III.**
Ranking of the BIM drivers as important to quantity surveying profession

| BIM drivers | Obafemi Awolowo University, Ile-Ife Academic staff Mean | SD | Rank | Students Mean | SD | Rank | Mann–Whitney Z-value | Sig. | Federal University of Technology, Akure Academic staff Mean | SD | Rank | Students Mean | SD | Rank | Mann–Whitney Z-value | Sig. | Total Mean | Total rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D01. Desire for innovation to remain competitive | 3.80 | 1.55 | 1 | 3.89 | 0.80 | 5 | 0.694 | 0.488 | 4.41 | 0.71 | 1 | 4.18 | 0.72 | 1 | 1.188 | 0.235 | 4.07 | 1 |
| D02. Improving the capacity to provide whole life value to client | 3.30 | 1.42 | 4 | 4.00 | 0.92 | 2 | −1.398 | 0.162 | 4.24 | 0.66 | 2 | 3.86 | 0.67 | 3 | 1.950 | 0.051 | 3.85 | 2 |
| D03. Availability of trained staff (from academia and industry) using BIM to teach the students | 3.30 | 1.64 | 6 | 3.96 | 0.90 | 4 | −0.926 | 0.354 | 4.06 | 0.83 | 7 | 3.82 | 0.98 | 4 | 0.696 | 0.486 | 3.79 | 5 |
| D04. BIM Software availability and affordability | 3.30 | 1.83 | 8 | 3.74 | 1.23 | 10 | −0.642 | 0.521 | 4.24 | 0.83 | 4 | 3.64 | 1.06 | 9 | 2.124 | 0.034* | 3.73 | 6 |
| D05. Enabling environment-Provision of IT infrastructure | 3.40 | 1.71 | 2 | 3.81 | 1.08 | 7 | −0.534 | 0.593 | 4.12 | 0.70 | 5 | 3.90 | 0.89 | 2 | 0.760 | 0.447 | 3.81 | 3 |
| D06. Cooperation and commitment of professional bodies to its implementation | 3.20 | 1.62 | 10 | 4.00 | 0.88 | 1 | −1.322 | 0.186 | 3.94 | 0.75 | 11 | 3.78 | 0.84 | 6 | 0.482 | 0.630 | 3.73 | 6 |
| D07. Government support through legislation | 3.40 | 1.90 | 3 | 3.63 | 1.01 | 11 | 0.123 | 0.902 | 4.06 | 0.90 | 8 | 3.78 | 1.06 | 7 | 0.897 | 0.370 | 3.72 | 8 |
| D08. Awareness of BIM tangible benefits | 3.30 | 1.57 | 5 | 3.89 | 0.94 | 6 | −0.924 | 0.355 | 4.24 | 0.67 | 3 | 3.78 | 0.79 | 5 | 2.063 | 0.039* | 3.80 | 4 |
| D09. Strong support from university management and industry | 3.30 | 1.70 | 7 | 3.78 | 1.05 | 8 | −0.619 | 0.536 | 3.94 | 0.66 | 10 | 3.62 | 0.97 | 10 | 1.106 | 0.269 | 3.66 | 10 |
| D10. Accreditation standards and requirements to guide the implementation of BIM within the curriculum | 3.20 | 1.81 | 11 | 3.74 | 1.13 | 9 | −0.618 | 0.537 | 4.06 | 0.75 | 6 | 3.50 | 1.09 | 11 | 1.780 | 0.075 | 3.63 | 11 |
| D11. Awareness of the IT among quantity surveyors | 3.20 | 1.48 | 9 | 4.00 | 0.96 | 3 | −1.524 | 0.128 | 3.88 | 1.11 | 12 | 3.72 | 1.09 | 8 | 0.670 | 0.503 | 3.70 | 9 |
| D12. Clients' demand for the use BIM in their project | 3.00 | 1.70 | 12 | 3.44 | 1.09 | 12 | −0.703 | 0.482 | 4.06 | 1.09 | 9 | 3.18 | 1.17 | 12 | 2.789 | 0.005* | 3.42 | 12 |

**Note:** ** Significant at $p < 0.05$

**Table IV.** Ranking of the BIM benefits as important to quantity surveying profession

| BIM benefits | Obafemi Awolowo University, Ile-Ife Academic staff Mean | SD | Rank | Students Mean | SD | Rank | Mann–Whitney Z-value | Sig. | Federal University of Technology, Akure Academic staff Mean | SD | Rank | Students Mean | SD | Rank | Mann–Whitney Z-value | Sig. | Total Mean | Total rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B01. BIM provides fast, effective and efficient quantity take-off and cost estimation | 3.90 | 1.10 | 5 | 4.52 | 0.70 | 1 | −1.994 | 0.046 | 4.53 | 0.51 | 2 | 4.40 | 0.73 | 1 | 0.379 | 0.705 | 4.34 | 1 |
| B02. Produce reliable and accurate quantities as well as competitive cost estimates | 3.90 | 1.20 | 6 | 4.30 | 0.82 | 3 | −0.902 | 0.367 | 4.59 | 0.51 | 1 | 4.00 | 0.64 | 2 | 3.218 | 0.001* | 4.20 | 3 |
| B03. It updates cost plans with more details as design is developed | 3.84 | 1.20 | 8 | 4.04 | 0.85 | 8 | −0.036 | 0.971 | 4.12 | 0.99 | 10 | 3.92 | 0.63 | 5 | 1.625 | 0.104 | 3.98 | 7 |
| B04. It generates accurate cost estimates for various design alternatives | 4.00 | 1.15 | 3 | 4.11 | 0.80 | 5 | 0.110 | 0.912 | 4.24 | 0.66 | 7 | 3.78 | 0.71 | 13 | 2.245 | 0.025 | 4.03 | 6 |
| B05. Time savings in the preparation of estimating costs | 3.85 | 1.20 | 7 | 4.33 | 0.73 | 2 | −0.983 | 0.326 | 4.29 | 0.59 | 5 | 4.00 | 0.88 | 3 | 1.115 | 0.265 | 4.12 | 5 |
| B06. Reduction of requests for information | 3.80 | 1.32 | 10 | 3.74 | 0.98 | 13 | 0.534 | 0.593 | 3.76 | 0.83 | 13 | 3.88 | 0.82 | 7 | −0.477 | 0.633 | 3.80 | 13 |
| B07. Clash detection to reduce design errors | 3.80 | 1.40 | 11 | 3.81 | 0.92 | 12 | 0.416 | 0.678 | 3.71 | 1.16 | 14 | 3.74 | 0.75 | 14 | 0.420 | 0.674 | 3.77 | 14 |
| B08. Simplify cost checking and update | 3.70 | 1.16 | 13 | 4.00 | 0.78 | 10 | −0.596 | 0.551 | 4.12 | 0.49 | 9 | 3.94 | 0.82 | 4 | 0.714 | 0.475 | 3.94 | 9 |
| B09. Improved visualization for better understanding of designs for measurement and minimize omissions | 3.70 | 1.33 | 14 | 4.07 | 0.96 | 7 | −0.667 | 0.505 | 4.12 | 1.90 | 11 | 3.82 | 0.92 | 12 | 1.146 | 0.252 | 3.92 | 11 |
| B10. Automatic quantification of BOQs preparation | 3.80 | 1.55 | 12 | 4.04 | 1.02 | 9 | −0.054 | 0.957 | 4.06 | 0.75 | 12 | 3.82 | 0.77 | 11 | 1.038 | 0.299 | 3.93 | 10 |
| B11. Data storage in central coordinated model | 3.80 | 1.23 | 9 | 3.85 | 1.10 | 11 | −0.036 | 0.971 | 4.29 | 0.77 | 6 | 3.84 | 0.93 | 10 | 1.752 | 0.080 | 3.95 | 8 |
| B12. Enhance communication and collaboration amongst team members | 4.30 | 1.34 | 1 | 4.07 | 0.78 | 6 | 1.407 | 0.159 | 4.47 | 0.72 | 4 | 3.88 | 0.87 | 8 | 2.467 | 0.014* | 4.18 | 4 |
| B13. Improve cost database management which reduces loss of information | 4.20 | 1.23 | 2 | 4.22 | 0.89 | 4 | 0.278 | 0.781 | 4.53 | 0.62 | 3 | 3.92 | 0.88 | 6 | 2.563 | 0.010* | 4.22 | 2 |
| B14. Rapid identification of design changes | 4.00 | 1.25 | 4 | 3.56 | 1.09 | 14 | 1.350 | 0.177 | 4.18 | 0.64 | 8 | 3.86 | 0.93 | 9 | 1.225 | 0.221 | 3.90 | 12 |

**Note:** ** Significant at $p < 0.05$

of 5 per cent. This implies that the *p*-value for each factor is significant if it is less than 0.05 (see Table III and Table IV). This approach was supported by earlier studies. For example, Olawumi and Chan (2018) carried out Mann–Whitney test for both the academics and practitioners' groups as well as the West versus the East groups, when evaluating the perceived benefits of integrating BIM and sustainability practices in construction projects. Famakin *et al.* (2012) conducted the Mann–Whitney test to determine the difference in the sample means of two groups comprised consultants and partners in the ranking of success factors for a joint venture in Nigeria.

## Results and discussion

*Background information of respondents*

Figure 1 indicates the background information of the academic staff in quantity surveying (QS) department from the two selected universities comprised OAU and FUTA. It can be seen from Figure 1 that the background information of academic staff only was indicated. It is because the other category of respondent was final year undergraduate students in the QS department from the aforementioned two universities. Therefore, there is no need for any further background information regarding the students. Figure 1 reveals the background information of the academic staff in terms of academic qualification, designation of

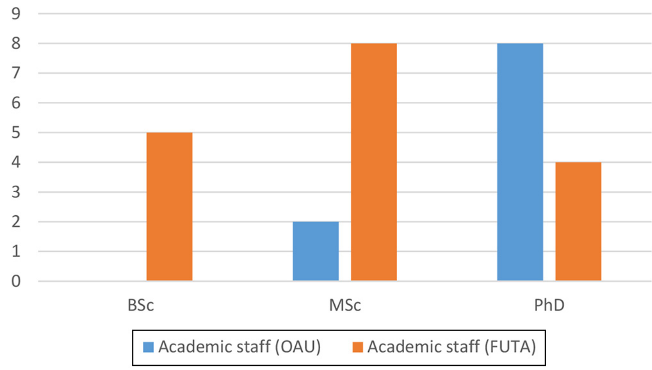


**Figure 1.**
Highest academic qualification of academic staff in the two universities

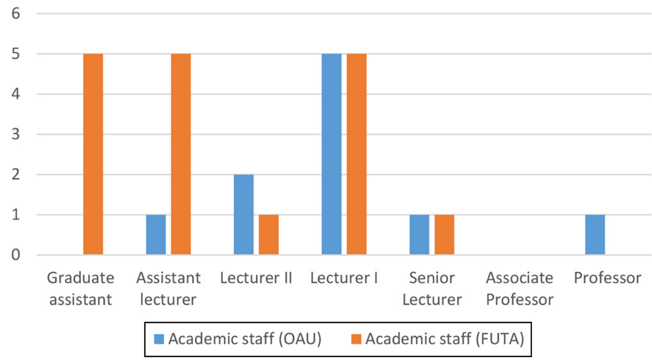


**Figure 2.**
Designation of academic staff academic staff in the two universities

academic staff and year of service as an academic staff undertaken by the respondents in the two selected universities. The academic qualifications of respondents revealed that the majority of the respondents had PhD, followed Master's Degree. It can also be seen from Figure 1 that the designation of the respondents cut across the academic staff cadre in a university (see Figures 1-3 for details).

*Ranking of the building information modelling drivers in the order of perceived importance to quantity surveying profession*

Table III indicates the ranking for each of the 12 identified BIM drivers from two different groups comprised academic staff and students in the two selected universities. Based on a five-point Likert scale, an attribute was deemed important if it had a mean value of 3.5 or more (Badu *et al.*, 2012; Babatunde *et al.*, 2016). In each two group ranking, given two or more identified factors (see Table III) with the same mean value, the one with the lowest standard deviation was assigned highest importance ranking (Field, 2005). In addition, based on the total ranking, the identified factors that have the same total mean values were given the same rank (see Table III). The analysis of the ranking in terms of the total mean score values for the 12 identified BIM drivers ranging from 3.42 to 4.07, this indicates that almost all the identified BIM drivers are considered by respondents as important. For instance, it can be seen from Table III that 11 (out of 12) identified BIM drivers had total mean values between 3.63 and 4.07, which are considered as important drivers for the BIM implementation by the respondents. Also, as shown in Table III, the top five ranked BIM drivers are: desire for innovation to remain competitive; improving the capacity to provide whole life value to client; enabling environment-provision of IT infrastructure; awareness of BIM tangible benefits; and availability of trained staff from academia and industry with their total mean values of 4.07, 3.85, 3.81, 3.80 and 3.79, respectively.

The only factor that ranked least was clients' demand for the use of BIM in their project with the total mean value of 3.42 (see Table III). This is not surprising because the adoption of BIM is still at the infant stage in the Nigerian construction industry and the majority of the clients comprised public and private clients are not fully aware of BIM benefits, as it is difficult to find the completed projects where BIM was used in Nigeria. This study finding is in contrast with previous studies, particularly in the UK and Australia. For instance, in the UK and Australia, the government is widely cited as the key driving force for BIM adoption. For example, both the UK and Australia governments have set a target of 2016 for compulsory BIM use on public sector projects (BuildingSMART Australasia, 2012; Eadie *et al.*, 2013). In addition, National Building Specification (NBS) (2012) reported that from the

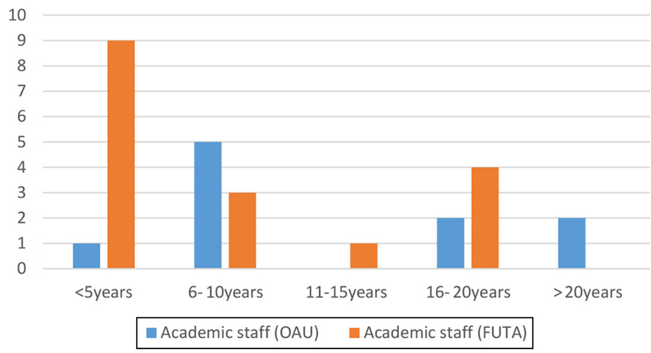


**Figure 3.**
Year of service as academic staff in the two universities

year 2010 to 2011 in the UK, construction professionals using BIM were more than doubled (from 13 per cent to 31 per cent). This rapid uptake of BIM is largely attributed to proven business benefits from its implementation, e.g. increased profits and positive returns on investment (NBS, 2012). Similarly, in the UK, Eadie *et al.* (2013) found that the three most important drivers for BIM implementation are clash detection, government pressure and competitive pressure.

To determine whether there is a statistically significant difference in perceptions of the respondents on the ranking of 12 identified BIM drivers. The Mann–Whitney test was conducted at a significance level of 5 per cent. Based on the results of the Mann–Whitney test at OAU, there is no statistically significant difference in perceptions of the academic staff and students on BIM drivers as important to QS profession. Since their *p*-values are greater than 0.05 (see Table III). On the other hand, at FUTA, the results of the Mann–Whitney test indicated a very slight statistically significant difference on three (out of 12) identified BIM drivers. These three drivers are: BIM software availability and affordability; awareness of BIM tangible benefits; and clients' demand for the use of BIM in their project. This little significant difference could be attributed to the maturity of the respondents in relation to the BIM implementation.

*Ranking of the building information modeling benefits in the order of perceived importance to quantity surveying profession*

Table IV shows the analysis of the ranking in terms of the total mean score values for the 14 identified BIM benefits ranging from 3.77 to 4.34; this indicates that all the identified BIM benefits are considered by respondents as important benefits of BIM implementation in relation to the QS profession. This is supported by Badu *et al.* (2012) that an attribute was deemed important if it had a mean score value of 3.5 or more on a five-point Likert scale. It can be seen further from Table IV that six (out of 14) identified BIM benefits have mean score values between 4.03 and 4.34, and the remaining eight BIM benefits have mean score values between 3.77 and 3.98. In addition, the top six ranked BIM benefits that displayed mean score values ranging from 4.03 to 4.34 are: BIM provides fast, effective and efficient quantity take-off and cost estimation; improve cost database management which reduces loss of information; produce reliable and accurate quantities as well as competitive cost estimates; enhance communication and collaboration amongst team members; time savings in the preparation of estimating costs; and it generate accurate cost estimates for various design alternatives, respectively. This study finding affirms the previous studies, especially Stanley and Thurnell (2014) who asserted that there is huge potential for BIM use by quantity surveyors for such tasks as quantity take-offs, estimation and cost management, in a collaborative project environment. This finding is not surprising because the top six ranked BIM benefits are perceived importance of BIM in relation to the QS profession by the respondents. Therefore, the QSs both in the industry and academia including quantity surveying students need to improve their knowledge and skills in BIM and apply BIM into their daily practices. This is supported by Nagalingam *et al.* (2013) who claimed that understanding the BIM is compulsory for QSs and incorporation of BIM into the QS profession would make the QSs perform their practices better in a sustainable manner. Moreover, to test if there is any significant difference in the perceptions of the respondents on the ranking of 14 identified BIM benefits in relation to QS profession. The Mann–Whitney test was conducted at a significance level of 5 per cent cut-off. The results of the Mann–Whitney test (see Table IV) indicated that there is no statistically significant difference in perceptions of the respondents at OAU on the ranking of the BIM benefits as important to the QS profession. While at FUTA, there is a statistically significant difference on three (out of 14) identified BIM benefits in relation to the QS profession. Since their *p*-values are less than 0.05 (see Table IV for details).

**Conclusions**

This study provided empirical evidence on the current perceptions of the drivers and benefits of BIM implementation in relation to the QS profession. The study identified 12 BIM drivers and the analysis of the ranking in terms of the total mean score values for the 12 identified BIM drivers indicated that almost all the identified BIM drivers are considered by respondents as important. The study further revealed the top five ranked BIM drivers as follows: the desire for innovation to remain competitive; improving the capacity to provide whole life value to the client; enabling environment-provision of IT infrastructure; awareness of BIM tangible benefits; and availability of trained staff from academia and industry, respectively. The only factor that ranked least was clients' demand for the use of BIM in their project. This is not surprising because the adoption of BIM is still at an infant stage in the Nigerian construction industry and the majority of the clients comprised public and private clients are not fully aware of BIM benefits, as it is difficult to find the completed projects where BIM was used in Nigeria. This study finding is in contrast with previous studies, particularly in the UK and Australia, where the government is widely cited as the key driving force for BIM adoption.

Similarly, the study identified 14 BIM benefits and the analysis of the ranking in terms of the total mean score values indicated that all the identified BIM benefits are considered by respondents as important benefits for the BIM implementation in relation to the QS profession. In addition, the top six ranked BIM benefits that displayed mean score values ranging from 4.03 to 4.34 are: BIM provides fast, effective and efficient quantity take-off and cost estimation; improve cost database management which reduces loss of information; produce reliable and accurate quantities as well as competitive cost estimates; enhance communication and collaboration amongst team members; time savings in the preparation of estimating costs; and it generate accurate cost estimates for various design alternatives, respectively. This study finding affirms the previous studies that alluded to the huge potential for BIM use by quantity surveyors for such tasks as quantity take-offs, estimation and cost management, in a collaborative project environment. Therefore, the QSs both in the industry and academia including quantity surveying students need to improve their knowledge and skills in BIM and apply BIM into their daily practices. Hence, understanding the BIM is compulsory for QSs and incorporation of BIM into the QS profession would make the QSs perform their practices better in a sustainable manner.

In addition, the results of the Mann–Whitney test were conducted on both the BIM drivers and benefits as important to the QS profession. The result indicated that there was no statistically significant difference in perceptions of the respondents at OAU. While at FUTA, a very slight statistically significant difference was found. This could be attributed to the lived experience of the respondents and their familiarity with quantity surveying practice in the industry. This study is not without limitations. For instance, the respondents considered in this study were academic and final year undergraduate students, considering respondents from the industry would have enhanced the credibility of the findings. Also, the use of questionnaire survey allows a large sample to be captured, other methods such as interviews might have been conducted to complement questionnaire survey with a view to revealing the country-specific BIM drivers and benefits as important to the QS profession, which may enrich the findings. However, the findings of this study provide useful insights about BIM to the QS professionals and students as they explore the concept for the advancement of the QS profession. Also, this study contributes to improving the QS graduates and professional quantity surveyors understanding of the BIM knowledge applicable to the QS profession; thereby enable the QS understands the benefits of BIM to their role. Further studies should be conducted in other countries to derive the specific country's BIM drivers and benefits as important to the QS profession.

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**Corresponding author**
Solomon Olusola Babatunde can be contacted at: sobabatunde80@gmail.com

# Barriers to the incorporation of BIM into quantity surveying undergraduate curriculum in the Nigerian universities



Solomon Olusola Babatunde
*Faculty of Engineering and the Built Environment, University of Johannesburg, Johannesburg, South Africa, and*
Damilola Ekundayo
*School of the Built Environment, University of Salford, Salford, UK*

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## Abstract

**Purpose** – In developing countries, adoption of building information modelling (BIM) concept within the architecture, engineering and construction (AEC) curricula in universities is a relatively new effort, and subsequently, studies on the status of BIM implementation in universities are rare. This study, therefore, becomes imperative with a view to identifying and examining the barriers to the incorporation of BIM into quantity surveying (QS) undergraduate curriculum in Nigerian universities.

**Design/methodology/approach** – The study adopted a questionnaire survey, which was targeted at the academia and students from two selected universities offering QS honours degree programme. Data collected were analysed using mean score, Mann–Whitney test and factor analysis.

**Findings** – The study identified 30 barriers, and the analysis of the ranking revealed that 17 (out of 30) identified barriers were considered as the most serious barriers. The study, through factor analysis, grouped the 30 identified barriers into six major factors.

**Practical implications** – The findings provide greater insights and empirical evidence on the major barriers to implementation of BIM education in developing countries.

**Originality/value** – The identified barriers are relevant not only to QS education but also to other related disciplines within the AEC context. These findings would be of great value to academic staff and university management board to develop strategies for incorporating BIM into AEC disciplines curricula in developing countries at large.

**Keywords** Higher education, BIM, Curriculum, Developing countries, Barriers, Quantity surveying

**Paper type** Research paper

## Introduction

Building information modelling (BIM) has been widely acknowledged as an emerging technological and procedural shift within the architecture, engineering and construction (AEC) industry (Panuwatwanich *et al.*, 2013). There is a growing demand for higher education institutions (HEIs) to incorporate BIM into their construction education degrees curricula, in this case for quantity surveying (QS) honours degree programmes to equip new graduates with such knowledge and preparing QS graduates for more employment in the industry. This is aligned with the observation by Keraminiyage and Lill (2013) that studying at HEIs is a primary mode of knowledge and skills enhancement for construction professionals. This is affirmed by Perera *et al.* (2017) that updating of knowledge and skills for construction graduates becomes imperative and it is a clarion call for those responsible

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for programme development in HEIs to be on the lookout for appropriate areas of expansion, innovation and adjust where possible to changing professional needs. It is on this premise that a number of universities around the world are offering courses for various BIM applications.

Existing studies have reported the adoption of BIM technologies in many developed countries such as USA, UK, Australia, The Netherlands, Singapore, Hong Kong and New Zealand (Isikdag and Underwood, 2010; Wong *et al.*, 2011) with impressive outcomes, despite some challenges to the adoption of BIM. Olatunji *et al.* (2010) advocated for the full adoption of BIM technologies across all disciplines. This is supported by Han and Bedrick (2015) that BIM adoption will suffer without its incorporation into education. Therefore, it is important for HEIs to incorporate BIM into their programmes with the support from government and industry (NATSPEC, 2013). This will ensure a continuous production of BIM-ready graduates and prepared the graduates for more employment in the industry. It is against this backdrop that the UK Government mandated that all public building projects are required to use BIM from the year 2016 (McGough *et al.*, 2013; Eadie *et al.*, 2015). Due to this reason and to satisfy the AEC industry requirements, many of the UK universities have started integrating BIM concept into AEC education (Abbas *et al.*, 2016). For instance, Adamu and Thorpe (2015) identified that some UK universities such as Westminster University, Middlesex, Salford, Liverpool (in London), the University of West of England, Northumbria University and the University of South Wales are already offering several BIM-related courses in their AEC programmes.

In the USA, Sacks and Pikas (2013) indicated that very few of the universities have incorporated BIM content into their AEC curricula. Some of these universities include Auburn University, Philadelphia University, University of Washington, University of Arkansas at Little, University of Southern California, MT State University and Purdue University. Other countries like Australia, New Zealand and Hong Kong have also dealt with the integration process of BIM into AEC curricula in some of their universities. Therefore, it is evident that a number of universities worldwide are offering courses for various BIM applications within AEC programmes, while several others are under the process of integrating BIM into their curricula. In Nigeria, however, adoption of BIM concept in universities AEC curricula is a relatively new effort and studies on the status of BIM implementation in universities are not very common. For instance, similar previous studies include that by Babatunde *et al.* (2018), who focused on the drivers and benefits of BIM incorporation into QS profession in Nigeria. The study found that understanding the BIM is compulsory for QS and incorporation of BIM into the QS profession would make the quantity surveyors perform their practices better in a sustainable manner. However, the study does not pay attention to the factors preventing the Nigerian universities from incorporating BIM into their AEC curricula unlike some universities in the developed countries. It is on this premise that this study becomes imperative with a view to identifying and examining the barriers to the incorporation of BIM into AEC curricula, in this case for QS undergraduate curriculum in the Nigerian Universities. The findings of this study would be of great value to academic staff and university management boards to develop practices for incorporating BIM concept into the QS curriculum in Nigeria and developing countries at large.

## Literature review

### *Building information modelling in quantity surveying profession*

QS is a profession that is well established in the British Commonwealth as being responsible for the management of cost and contracts in the construction industry (Pheng and Ming, 1997; Bowen *et al.*, 2008; Ling and Chan, 2008). The profession is also known as construction economics in Europe and cost engineering in the USA and parts of Asia (Pathirage and Amaratunga, 2006; Smith, 2009). Traditionally, the role of quantity surveyors is primarily associated with estimating and cost planning, procurement advice, measurement, preparation of bills of quantities, tender documentation, construction cost control and preparation of valuations, contractual claims and final accounts (Ashworth and Hogg, 2007). Following the emergence of BIM, some of the aforementioned quantity surveyor roles could be achieved through BIM more efficiently (Ashworth and Hogg, 2007; Wu *et al.*, 2014). Therefore, it is important for quantity surveyors to appreciate BIM, understand its potential, and develop effective processes to integrate BIM into their current practices (Cartlidge, 2011).

Existing studies in this area have highlighted the reasons of integrating BIM into the QS profession (Sabol, 2008; Eastman *et al.*, 2011). For instance, Thomas (2010) identified some reasons such as: 30 per cent of the projects do not meet original programme or budget; 37 per cent of materials used in construction become waste; 10 per cent of the cost of a project is typically due to change orders; and 38 per cent of carbon emissions are from buildings not cars. Sabol (2008) described that during conventional (e.g. manual) project development, accurate, actionable costing information has been difficult to define during preliminary project phases. This process is prone to human error and tends to propagate inaccuracies. The quantification is time-intensive, and it requires 50 per cent to 80 per cent of a cost estimator's time on a project. However, the development of early cost estimates is widely facilitated by BIM (Sabol, 2008). This is supported by Nagalingam *et al.* (2013) who avers that BIM reduces the resources needed for a construction project and costs are saved on the reduction of resources. This is affirmed by Gier (2015) that BIM is a helpful teaching tool for construction estimation, quantity take-off and highly contribute to design comprehension skills and understanding of construction materials, methods, and processes.

*State of building information modelling in the Nigerian construction industry*

There is very little evidence that BIM is widespread in the Nigerian construction industry, and this is evident in the lack of literature precisely on the subject. Conversely, a number of studies have examined the uptake of information and communications technology (ICT) by construction professionals in Nigeria and the challenges to its implementation in practice. However, the review of extant literature revealed that some improvements are required to construction education as regards BIM implementation. According to Oladapo (2006, 2007), the main uses of ICT in the industry are word processing, internet communications, costing and work scheduling. Ibironke *et al.* (2011) examined the current state and use of ICT by quantity surveyors in Nigeria. The research revealed that despite the awareness of the importance of ICT in improving service delivery and productivity, the level of adoption by quantity surveyors in Nigeria is still very low and BIM tools such as Auto Cad, Revit, Master Bill, QS Cad, Win QS and CATO are yet to be fully exploited.

Musa *et al.* (2010) concluded that harnessing appropriate ICT tools would improve the quality of QS services in the country. In addition, several other studies have buttressed this assertion (Ibironke *et al.*, 2011; Olanrewaju, 2016; Dada and Musa, 2016; Dada, 2017). There is a clear-cut evidence that ICT has numerous benefits but the implementation in practice is one of a different story in the Nigerian construction sector (Oladapo, 2006; Waziri *et al.*, 2015). Perhaps we should look to the providers of construction-related education in Nigeria to instil students with increasing awareness of BIM. Conversely, it may be that there are genuine and important barriers to the incorporation of ICT, especially BIM, into HEI curricula. In the current era, the need for value-added services, complexity of modern construction infrastructure and on-time delivery of projects are few of the factors necessitating the use of modern ICT as a viable tool to improve the quality of QS services. Although a limited number of construction firms in Nigeria have been adopting and using basic ICT for their services since late 1980s (Musa *et al.*, 2010), the use and benefits of BIM has not been fully realised in the sector as a whole (Ikediashi and Ogwueleka, 2016). It becomes pertinent therefore to explore the minimal uptake of BIM in the Nigerian AEC sector. This is the focus of this study. It established empirical barriers to implementation of BIM education in Nigerian higher education programmes.

### *Barriers to building information modelling incorporation into curricula in higher education institutions*

There is no known conclusive empirical study on barriers to the incorporation of BIM into QS education in Nigeria. Therefore, the research offers a fresh understanding around what is happening in the Nigerian AEC sector as regards BIM implementation and the challenges of its integration into construction curriculum not only in Nigeria but also elsewhere. While some of the barriers to BIM implementation are common; others are peculiar to Nigeria as a developing nation. Despite the fact that progress has been made in incorporating BIM into AEC curricula, particularly in developed countries such as the USA, the UK, Australia, New Zealand, Hong Kong and Singapore. The extant literature revealed the challenges of integrating BIM into the undergraduate curriculum, which are presented in Table I.

While reports abound on BIM education in the construction industry of developed countries, very little exists for developing countries such as Nigeria. This study therefore seeks to examine the barriers to the implementation of BIM education in Nigeria in the context of a developing economy. The constraints to the use of modern ICT in Nigeria, which this study focuses on include insufficient/irregular power supply, high cost of ICT hardware and software, low job order for firms, fear of virus attacks and high rate of obsolescence of ICT hardware and software amongst others (Oladapo, 2007). Musa *et al.* (2010) identified the lack of ICT infrastructural facilities, power supply in the country, education and training as some of the reasons limiting the uptake of BIM tools in practice. Other proponents in the field (Waziri *et al.*, 2015; Dada, 2017) agreed that education and training are paramount to developing quantity surveyors' ICT skills and knowledge and continuous professional development. Dada and Musa (2016) argued that educational training can be considered an integral part of organisation learning, change and skill development. In general, a review of the existing literature of ICT adoption in Nigeria revealed shortcomings in BIM implementation and education in comparison with what is obtained globally. In the light of the above, Dada (2017) opined that there is need to understand the identified gap in construction education provided by relevant stakeholders, especially the academic institutions offering QS programmes in Nigeria.

In developing countries such as Nigeria, adoption of BIM concept in universities AEC curricula is relatively a new effort and studies on the status of BIM implementation in academia are not very common (Alkalbani *et al.*, 2012; Olanrewaju, 2016). While the above studies have provided useful insights into the current state of ICT in the Nigerian construction industry and barriers to its implementation in practice, none has investigated the barriers to the implementation of BIM education in Nigerian HEIs. It is on this premise that this study becomes imperative with a view to identifying and examining the barriers to the incorporation of BIM into AEC curricula, in this case for QS undergraduate curriculum in the Nigerian universities. This was not done in previous studies. For the Nigerian quantity surveyors to attain the required competence standard in BIM practice, BIM education is crucial (Dada and Musa, 2016), and the barriers to its implementation in QS programmes need to be explored.

| S/n | Barriers | References |
|---|---|---|
| 1 | There is a lack of accreditation standards and requirements to guide the implementation of BIM within a curriculum | Sabongi (2009), Wong *et al.* (2011), Sacks and Pikas (2013) |
| 2 | Integrating different areas of the curriculum to realise the multidisciplinary aspect of BIM is problematic | Sabongi (2009), Wong *et al.* (2011), Sacks and Pikas (2013) |
| 3 | There is no room in the existing curriculum for additional classes/courses | Sabongi (2009), Clevenger *et al.* (2010) |
| 4 | BIM demands new teaching methods | Gordon *et al.* (2009), Clevenger *et al.* (2010) |
| 5 | There is a lack of BIM-specific materials and textbooks and other educational resources for students | Sabongi (2009), Gier (2015) |
| 6 | Modelling requires expert construction knowledge that is not easily understood by students, especially when they lack work experience | Sabongi (2009), Guo and London (2010), Sylvester and Dietrich (2010) |
| 7 | It is difficult to educate the lecturers due to rapidly evolving technology | Becerik-Gerber *et al.* (2011), Alabdulqader *et al.* (2013) |
| 8 | BIM is resource-intensive | Gordon *et al.* (2009), Sacks and Pikas (2013), Puolitaival and Forsythe (2016) |
| 9 | BIM is problematic for people with weak general IT skills | Taylor *et al.* (2008), Gordon *et al.* (2009) |
| 10 | What to include in BIM course | Panuwatwanich *et al.* (2013), Sacks and Pikas (2013) |
| 11 | Disagreement over BIM concept is concerned whether BIM is a methodological process or a software tool | Clevenger *et al.* (2010), Becerik-Gerber *et al.* (2011), Panuwatwanich *et al.* (2013) |
| 12 | Need for strong fundamental knowledge for the students before being able to undertake BIM | Panuwatwanich *et al.* (2013), Gier (2015) |
| 13 | Need for industry involvement i.e. the need to engage expert industry practitioners in the development and delivery of a BIM curriculum | Lee and Dossick (2012), Panuwatwanich *et al.* (2013) |
| 14 | Resistance to change – difficulty in introducing BIM in an already well-established curriculum | Becerik-Gerber *et al.* (2011), Panuwatwanich *et al.* (2013) |
| 15 | Which BIM software should be taught to the students | Panuwatwanich *et al.* (2013) |
| 16 | Traditional (and current) programme structures-refers to the typical isolated, discipline-specific programme structure that exists in most universities | Gordon *et al.* (2009), Panuwatwanich *et al.* (2013) |
| 17 | Inadequate/erratic power supply | Oladapo (2007) |
| 18 | Fear of virus attacks/high security risk | Oladapo (2007) |
| 19 | Availability of qualified staff to take BIM course | Oladapo (2007), Lee and Dossick (2012) |
| 20 | Need to continually upgrade the BIM software | Oladapo (2007) |
| 21 | Cost of training the staff/lecturers | Efficiency and Reform Group (2011), Eadie *et al.* (2015) |
| 22 | Staff resistance/reluctance to initiate new workflow | Arayici *et al.* (2009), Becerik-Gerber *et al.* (2011), Eadie *et al.* (2015) |
| 23 | ICT literacy of staff or lack of technical expertise | Arayici *et al.* (2009), Eadie *et al.* (2015) |
| 24 | Lack of vision of BIM tangible benefits | Arayici *et al.* (2011), Lee *et al.* (2012) |
| 25 | Lack of university management support | Arayici *et al.* (2011), Jung and Joo (2011) |
| 26 | Lack of IT infrastructure or poor internet connectivity | Oladapo (2007) |
| 27 | Lack of government lead/direction | Australian Institute of Architects (AIA) (2010) |
| 28 | Lack of space and facilities to accommodate BIM | Sabongi (2009), Sacks and Pikas (2013) |
| 29 | Difficulty to appoint industry expert | Becerik-Gerber *et al.* (2011), Macdonald (2012) |
| 30 | Lack of collaboration with industry expert | Becerik-Gerber *et al.* (2011), Lee and Dossick (2012) |

**Table I.** Barriers to incorporation of BIM into curriculum in HEIs

## Research methodology

Previous studies conducted on the integration of BIM within the AEC curricula surveyed between one and three key stakeholders to include the academic staff, students and professionals within AEC industry. For example, Clevenger *et al.* (2010) administered questionnaires to students when exploring the incorporation of BIM into the construction management curriculum. Hedayati *et al.* (2015) surveyed both the students and lecturers when exploring the obstacles to implementing BIM in educational system. Abbas *et al.* (2016) sampled only academic staff (i.e. faculty members) when assessing the current state of BIM into the construction management programme within the engineering universities in Pakistan. Also, few studies adopted literature review (Lee and Dossick, 2012; Elinwa and Agboola, 2013). Therefore, this study adopted a literature review, a desk review and two questionnaire surveys of academia and students within the case studies of two selected public federal universities in southwestern Nigeria, Obafemi Awolowo University (OAU), Ile-Ife, and the Federal University of Technology Akure (FUTA), that offer QS honours degree programmes in Nigeria. The rationales for selecting these two universities are as follows:

- They are the leading universities offering QS honours degree programmes for over three decades in southwestern Nigeria.
- Their QS programmes are fully accredited by both the National Universities Commission and the Quantity Surveyors Registration Board of Nigeria.
- They have the highest number of QS students' enrolment at undergraduate study.
- They already have a dedicated QS software packages laboratory for teaching students measurement and estimating.

The methodology adopted for this study comprised a literature review, desk review, and two surveys of academia and students, which are detailed as follows.

### *Literature review*

An extensive literature review was carried out to identify the various barriers to the incorporation of BIM into the AEC programmes in HEIs. These were identified from the significant literature. Thus, the outcome of literature review produced 30 barriers (see Table I for details).

### *Desk review*

The identified 30 barriers from the literature review were subjected to a desk review which comprised three academia in the QS Department at OAU, Ile-Ife, Nigeria. These three selected academia are actively involved in teaching students dedicated QS software for measurement and estimating (QS CAD, Masterbill Elite, Ripac, etc.) at undergraduate study. The three selected academia have vast experience of QS softwares and their applications. Thus, the feedback obtained from these three academia informed the development of the academia and student questionnaire surveys. This, therefore forms the basis of inquiry for the data collection and analysis.

### *Survey of the academia*

The identified barriers from the literature and desk review formed the basis of the survey questionnaire. The academic survey is one of the two surveys conducted in the case studies comprised two selected universities to include QS Department at OAU, Ile-Ife, and QS Department at FUTA. The total number of academic staff in the QS department from the two universities is 39 academic staff comprised 13 academic staff at OAU and 26 academic staff at FUTA. Due to the small sample size of the academic staff from both universities, the entire 39 academic staff were sampled. The survey received 10 and 17 responses from OAU and FUTA, respectively. This resulted in a total of 27 completed responses, representing 69 per cent, which were found suitable for the analysis.

*Survey of the students*

The student survey is the second survey conducted among the final year undergraduate students in the QS department from both universities – OAU and FUTA. The QS programme is five years (i.e. part/level 1 to part/level 5). The reasons for choosing final-year undergraduate students are: they have undergone several courses/modules relating to software applications for measurement and estimating (e.g. QS CAD, Masterbill Elite, Ripac etc), and they are mature and already exposed to the industry during their industrial attachement/intership. In 2016/2017 academic session, the total number of final-year undergraduate students in the QS department from the two universities is 161 students; 62 students at OAU and 99 students at FUTA. Therefore, for objectivity, half of final year undergraduate students in each university were randomly selected. Hence, 81 QS students comprised 31 QS students at OAU, and 50 QS students at FUTA were randomly sampled. The survey received 27 and 45 fully completed responses from OAU and FUTA, respectively. This resulting into a total of 72 fully completed responses.

The questionnaire designed for this study was structured and multiple-choice type. The questionnaire was divided into two sections. Section "A" comprised demographic information of the respondents, while Section "B" was designed in relation to the purpose of this study. The questions were asked on a five-point Likert scale rating with 5 being the highest of the rating. A reliability test was conducted on the five-point Likert scale in the questionnaire using Cronbach's alpha test through Statistical Package for Social Science (SPSS). The reliability coefficients value of Cronbach's alpha 0.872 was obtained, signifying that the questionnaire used for the study is reliable and indicates evidence of good internal consistency. This is supported by George and Mallery (2003) that Cronbach's alpha value of greater than 0.6 is considered acceptable. This is affirmed by Pallant (2007) that the value for Cronbach's alpha should be higher than 0.7 for the scale to be reliable. The data collected were analysed using SPSS through the use of descriptive statistics, mean score, Kruskal–Wallis test and factor analysis. The mean score was used for ranking of identified 30 barriers to the integration of BIM into QS undergraduate curriculum. Mann–Whitney test was carried out to determine whether there is statistically significant difference in perceptions of the respondents comprised academic staff and students on the ranking of 30 identified barriers. Also, factor analysis was used in data reduction to identify a small number of factors that explain most of the variance (Pallant, 2010; Hair *et al.*, 2010).

## Results and discussion

*Demographic information of respondents*

Table II indicates the demographic information of the academic staff in QS department from the two selected universities, OAU and FUTA. It can be seen from Table II that the background information of academic staff only was indicated. It is because the other category of respondents was final-year undergraduate students in the QS departments from the aforementioned two universities. In the context of this study, there is no need for any further background information regarding the students. Thus, Table II reveals the demographic information of the academic staff in terms of academic qualification, designation of academic staff and year of service as an academic staff undertaken by the

| Academic staff profile | Academic staff (OAU) | Frequency (%) | Academic staff (FUTA) | Frequency (%) |
|---|---|---|---|---|
| *Highest educational qualification* | | | | |
| BSc | – | – | 5 | 29.41 |
| MSc | 2 | 20.00 | 8 | 47.06 |
| PhD | 8 | 80.00 | 4 | 23.53 |
| Total | 10 | 100.00 | 17 | 100.00 |
| *Designation of academic staff* | | | | |
| Graduate assistant | – | – | 5 | 29.41 |
| Assistant lecturer | 1 | 10.00 | 5 | 29.41 |
| Lecturer II | 2 | 20.00 | 1 | 5.88 |
| Lecturer I | 5 | 50.00 | 5 | 29.41 |
| Senior lecturer | 1 | 10.00 | 1 | 5.88 |
| Associate professor | – | – | – | – |
| Professor | 1 | 10.00 | – | |
| Total | 10 | 100.00 | 17 | 100.00 |
| *Year of service as an academic staff* | | | | |
| <5 years | 1 | 10.00 | 9 | 52.94 |
| 6-10 years | 5 | 50.00 | 3 | 17.65 |
| 11-15 years | – | – | 1 | 5.88 |
| 16-20 years | 2 | 20.00 | 4 | 23.53 |
| >20 years | 2 | 20.00 | – | – |
| Total | 10 | 100.00 | 17 | 100.00 |

**Table II.** Demographic information of academic staff

respondents in the two selected universities. The academic qualifications of respondents revealed that the majority of the respondents had PhD, followed by a master's degree. It can also be seen from Table III that the designation of the respondents cuts across the academic staff cadre in university (see Table III for details).

*Ranking of the barriers to the incorporation of building information modelling into quantity surveying undergraduate curriculum*

Table III shows the analysis of the ranking for the 30 identified barriers to the incorporation of BIM into QS undergraduate curriculum as indicated by the respondents, which comprised academic staff and students in the two selected universities. Based on the five-point Likert rating scale, an attribute was deemed critical if it had a mean value of 3.5 or more (Badu *et al.*, 2012; Babatunde *et al.*, 2016). Given two or more identified barriers (Table III) with the same mean values, the one with the lowest standard deviation was assigned highest importance ranking (Field, 2005). The analysis of the ranking in terms of the total mean score values for the 30 identified barriers ranged from 2.96 to 4.01, indicating that not all the identified barriers are considered by respondents as critical barriers influencing the incorporation of BIM into QS undergraduate curriculum. It can be seen further from Table IV that 17 (out of 30) identified barriers scored mean values between 3.58 and 4.01, which are considered as important barriers (Badu *et al.*, 2012; Babatunde *et al.*, 2016).

Therefore, the highest total ranked 17 barriers that displayed mean score values ranging from 3.58 to 4.01 are as follows: lack of IT infrastructure or poor internet connectivity; BIM is resource-intensive; lack of government lead/direction; cost of training the staff/lecturers; availability of qualified staff to take BIM course; need to continually upgrade the BIM software; lack of accreditation standards and requirements to guide the implementation of

| Barriers | OAU, Ile-Ife | | | | | | | | FUTA | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Academic staff | | | Students | | | | | Academic staff | | | Students | | | | | | |
| | Mean | SD | Rank | Mean | SD | Rank | Mann-Whitney Z-Value | Sig. | Mean | SD | Rank | Mean | SD | Rank | Mann-Whitney Z-value | Sig. | Total mean | Total rank |
| B 01. There is a lack of accreditation standards and requirements to guide the implementation of BIM within a curriculum | 3.70 | 1.89 | 7 | 3.74 | 0.09 | 8 | 0.983 | 0.326 | 4.06 | 1.03 | 8 | 3.86 | 1.18 | 9 | 0.555 | 0.579 | 3.84 | 7 |
| B 02. Integrating different areas of the curriculum to realise the multidisciplinary aspect of BIM is problematic | 3.30 | 1.64 | 15 | 3.56 | 0.70 | 17 | 0.073 | 0.942 | 3.94 | 0.83 | 12 | 3.82 | 0.87 | 11 | 0.483 | 0.629 | 3.66 | 15 |
| B 03. There is no room in the existing curriculum for additional classes/courses | 2.40 | 1.35 | 28 | 3.07 | 1.11 | 30 | −1.305 | 0.192 | 3.29 | 1.10 | 24 | 3.66 | 1.08 | 26 | −1.199 | 0.231 | 3.11 | 26 |
| B 04. BIM demands new teaching methods | 3.30 | 1.16 | 14 | 3.52 | 0.89 | 21 | −0.519 | 0.604 | 3.71 | 1.10 | 17 | 3.84 | 1.08 | 10 | −0.366 | 0.714 | 3.59 | 16 |
| B 05. There is a lack of BIM-specific materials and textbooks and other educational resources for students | 3.00 | 1.25 | 20 | 3.56 | 1.05 | 19 | −1.260 | 0.208 | 4.06 | 1.25 | 10 | 3.72 | 1.13 | 22 | 1.422 | 0.155 | 3.58 | 17 |
| B 06. Modelling requires expert construction knowledge that is not easily understood by students, especially when they lack work experience | 3.10 | 1.20 | 16 | 3.37 | 1.01 | 27 | −0.517 | 0.605 | 3.41 | 0.94 | 22 | 3.76 | 1.08 | 18 | −1.429 | 0.153 | 3.41 | 22 |
| B 07. It is difficult to educate the lecturers due to rapidly evolving technology | 2.60 | 1.47 | 26 | 3.19 | 1.04 | 29 | −1.239 | 0.215 | 2.53 | 0.72 | 30 | 3.50 | 1.11 | 30 | −3.393 | 0.001* | 2.96 | 30 |
| B 08. BIM is resource-intensive | 3.90 | 1.37 | 4 | 3.78 | 1.03 | 7 | 0.659 | 0.510 | 4.41 | 0.62 | 1 | 3.92 | 1.12 | 7 | 1.432 | 0.152 | 4.00 | 2 |
| B 09. BIM is problematic for people with weak general IT skills | 3.60 | 1.37 | 8 | 3.67 | 1.18 | 14 | −0.143 | 0.886 | 4.00 | 0.87 | 11 | 3.92 | 1.07 | 6 | 0.076 | 0.940 | 3.80 | 10 |
| B 10. What to include in BIM course | 2.20 | 1.23 | 30 | 3.56 | 1.22 | 20 | −2.627 | 0.009* | 3.00 | 1.00 | 27 | 3.64 | 0.98 | 27 | −2.471 | 0.014* | 3.10 | 27 |
| B 11. Disagreement over BIM concept is concerned whether BIM is a methodological process or a software tool | 2.50 | 1.27 | 27 | 3.26 | 0.86 | 28 | −2.000 | 0.046 | 3.06 | 0.97 | 26 | 3.54 | 0.97 | 29 | −1.711 | 0.087 | 3.09 | 28 |
| B 12. Need for strong fundamental knowledge for the students before being able to undertake BIM | 3.10 | 1.29 | 17 | 3.52 | 0.98 | 22 | −0.788 | 0.431 | 3.41 | 0.62 | 21 | 3.82 | 1.04 | 13 | −1.740 | 0.082 | 3.46 | 20 |
| B 13. Need for industry involvement i.e. the need to engage expert industry practitioners in the development and delivery of a BIM curriculum | 3.50 | 1.08 | 9 | 3.67 | 0.88 | 13 | −0.163 | 0.870 | 4.12 | 0.70 | 6 | 3.76 | 0.96 | 17 | 1.315 | 0.188 | 3.76 | 12 |
| B 14. Resistance to change – difficulty in introducing BIM in an already well-established curriculum | 3.50 | 1.35 | 12 | 3.48 | 0.85 | 25 | 0.216 | 0.829 | 3.94 | 0.97 | 13 | 4.14 | 0.95 | 1 | −0.837 | 0.403 | 3.77 | 11 |
| B15. Which BIM software should be taught to the students | 2.30 | 1.06 | 29 | 3.37 | 0.93 | 26 | −2.916 | 0.004* | 2.88 | 1.11 | 29 | 3.74 | 0.94 | 20 | −2.680 | 0.007* | 3.07 | 29 |

(*continued*)

**Table III.** Ranking of the barriers to incorporation of BIM into QS undergraduate curriculum

Table III.

| Barriers | OAU, Ile-Ife Academic staff Mean | SD | Rank | Students Mean | SD | Rank | Mann-Whitney *Z*-Value | Sig. | FUTA Academic staff Mean | SD | Rank | Students Mean | SD | Rank | Mann-Whitney *Z*-value | Sig. | Total mean | Total rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B 16. Traditional (and current) programme structures-refers to the typical isolated, discipline-specific programme structure that exists in most universities | 2.60 | 1.43 | 25 | 3.52 | 1.05 | 24 | −1.843 | 0.065 | 3.41 | 1.12 | 23 | 3.92 | 0.90 | 5 | −1.701 | 0.089 | 3.36 | 24 |
| B 17. Inadequate/erratic power supply | 3.90 | 1.29 | 3 | 3.78 | 1.01 | 6 | 0.555 | 0.579 | 3.88 | 1.17 | 14 | 3.74 | 1.10 | 21 | 0.499 | 0.618 | 3.83 | 8 |
| B 18. Fear of virus attacks/high security risk | 3.10 | 1.60 | 18 | 3.59 | 0.97 | 15 | −0.935 | 0.350 | 3.59 | 1.06 | 19 | 3.66 | 1.06 | 25 | −0.320 | 0.749 | 3.49 | 18 |
| B 19. Availability of qualified staff to take BIM course | 4.00 | 1.33 | 2 | 3.70 | 0.99 | 11 | 1.070 | 0.285 | 4.06 | 1.14 | 9 | 3.76 | 1.20 | 19 | 1.010 | 0.313 | 3.88 | 5 |
| B 20. Need to continually upgrade the BIM software | 3.80 | 1.32 | 6 | 4.04 | 0.90 | 3 | −0.306 | 0.759 | 3.82 | 1.13 | 15 | 3.80 | 1.01 | 14 | 0.174 | 0.862 | 3.87 | 6 |
| B 21. Cost of training the staff/lecturers | 3.50 | 1.10 | 11 | 4.11 | 0.89 | 2 | −1.588 | 0.112 | 4.18 | 1.01 | 5 | 4.02 | 0.96 | 2 | 0.827 | 0.408 | 3.95 | 4 |
| B 22. Staff resistance/reluctance to initiate new workflow | 2.60 | 1.17 | 24 | 3.81 | 1.00 | 5 | −2.713 | 0.007* | 3.00 | 1.11 | 28 | 3.88 | 0.98 | 8 | −2.808 | 0.005* | 3.32 | 25 |
| B 23. ICT literacy of staff or lack of technical expertise | 3.00 | 1.33 | 21 | 4.15 | 0.86 | 1 | −2.488 | 0.013* | 3.59 | 1.28 | 20 | 4.02 | 1.04 | 3 | −1.227 | 0.220 | 3.69 | 14 |
| B 24. Lack of vision of BIM tangible benefits | 2.90 | 1.52 | 22 | 3.56 | 0.93 | 18 | −1.279 | 0.201 | 3.18 | 1.07 | 25 | 3.82 | 1.00 | 12 | −2.168 | 0.030* | 3.37 | 23 |
| B 25. Lack of university management support | 3.50 | 1.09 | 10 | 3.59 | 1.05 | 16 | −0.054 | 0.957 | 4.06 | 0.75 | 7 | 3.68 | 1.15 | 24 | 1.007 | 0.314 | 3.71 | 13 |
| B 26. Lack of IT infrastructure or poor internet connectivity | 3.90 | 1.40 | 5 | 3.93 | 0.78 | 4 | 0.416 | 0.677 | 4.41 | 0.71 | 2 | 3.78 | 1.22 | 16 | 1.860 | 0.063 | 4.01 | 1 |
| B 27. Lack of government lead/direction | 4.10 | 1.45 | 1 | 3.74 | 0.86 | 9 | 1.614 | 0.107 | 4.24 | 0.83 | 4 | 3.78 | 1.13 | 15 | 1.376 | 0.169 | 3.97 | 3 |
| B 28. Lack of space and facilities to accommodate BIM | 3.00 | 1.22 | 19 | 3.52 | 1.01 | 23 | −1.246 | 0.213 | 3.71 | 0.92 | 16 | 3.68 | 1.08 | 23 | −0.189 | 0.850 | 3.48 | 19 |
| B 29. Difficulty to appoint industry expert | 2.70 | 1.42 | 23 | 3.74 | 0.94 | 10 | −2.043 | 0.041 | 3.59 | 0.87 | 18 | 3.64 | 1.03 | 28 | −0.335 | 0.738 | 3.42 | 21 |
| B 30. Lack of collaboration with industry expert | 3.40 | 1.26 | 13 | 3.70 | 1.20 | 12 | −0.623 | 0.534 | 4.24 | 0.66 | 3 | 3.96 | 1.05 | 4 | 0.740 | 0.459 | 3.82 | 9 |

**Note:** *Significant at 0.05 (i.e.5%)

BIM within a curriculum; inadequate/erratic power supply; lack of collaboration with industry expert; BIM is problematic for people with weak general IT skills; resistance to change – difficulty in introducing BIM in an already well-established curriculum; need for industry involvement, i.e. the need to engage expert industry practitioners in the development and delivery of a BIM curriculum; lack of university management support; ICT literacy of staff or lack of technical expertise; integrating different areas of the curriculum to realise the multidisciplinary aspect of BIM is problematic; BIM demands new teaching methods; and lack of BIM-specific materials and textbooks, as well as other educational resources for students, respectively. The similar barriers were identified by several previous studies. For instance, Sabongi and Arch (2009) and Panuwatwanich *et al.* (2013) found that lack of time and resources to prepare a new curriculum, lack of space in established curriculum to include new courses and lack of suitable materials for BIM-related training are the main obstacles to integrating BIM into universities engineering undergraduate curriculum in developed countries. Abbas *et al.* (2016) identified lack of trained BIM faculty members, structure of existing education curriculum, need for the industry involvement, inadequate funding and unwillingness to change existing curriculum are top ranked barriers to integrating BIM into construction management programmes in Pakistani universities. In addition, it can be deduced from this study finding that there are more important barriers influencing the integration of BIM into undergraduate curriculum in the Nigerian universities.

The Mann-Whitney test was conducted to determine whether there is statistically significant difference in the perception of the respondents on the ranking of 30 identified barriers. The Mann–Whitney test was conducted at a significance level of 5 per cent. The results of the Mann–Whitney test indicated a very slight statistically significant difference on four and five (out of 30) identified barriers in perceptions of the respondents at OAU and FUTA, respectively (Table III). This little significant difference is not surprising because it could be connected with their lived experience of the respondents about the existing infrastructure in their respective university and their familiarity with QS practices in the industry.

### *Factor analysis of the barriers to the incorporation of building information modelling into quantity surveying undergraduate curriculum*

In an attempt to achieve more interpretable results and thereby determine the underlying relationships among the identified 30 barriers to BIM incorporation into QS undergraduate curriculum (see Table III), factor analysis was conducted. In assessing the suitability of data obtained for factor analysis, Kaiser–Meyer–Olkin (KMO) and Bartlett's test of sphericity were conducted using Statistical Package for the Social Sciences (SPSS).This approach was supported by Pallant (2010) who asserted that before embarking on factor analysis, the data must be assessed for suitability for factor analysis using KMO and Bartlett's tests of sphericity. Table IV revealed the results of KMO and Bartlett's tests of sphericity. The KMO value indicated the sampling adequacy to be 0.872 (see Table IV). This shows a satisfactory for accurate completion

| | |
|---|---|
| KMO measure of sampling adequacy | 0.872 |
| *Bartlett's test of sphericity* | |
| Approx. Chi-Square | 1.817E3 |
| df | 435 |
| Sig. | 0.000 |

**Table IV.** KMO and Bartlett's test

of factor analysis. This was supported by Tabachnick and Fidell (2007) that the KMO index ranges from 0 to 1, with 0.6 suggested as the minimum value for a good factor analysis. Similarly, the result of Bartlett's test of sphericity showed a recorded value of 0.000 (Table IV), which is considered appropriate for the factor analysis. This is corroborated by Pallant (2007) that the significance value should be 0.05 or less. It is evident that the data obtained were suitable for conducting factor analysis.

Therefore, factor analysis was conducted, and the factors with an eigenvalue greater than 1.0 were considered for further investigation. This is corroborated by a number of earlier researchers that the default position in making a decision about the number of factors to be considered in factor analysis is the "eigenvalue greater than 1.0 rule" (Pallant, 2010). It can be seen from Table V that six components were retained for further investigation after satisfying the eigenvalues greater than 1. Table V contains the six factors with their eigenvalues, the percentage of the variance and the cumulative percentage of the variance in each factor. It can be seen from Table V that the eigenvalues for the six factors retained were ranging from 1.205 to 5.227. The total variance explained by extracted six factors accounted for 66.077 per cent.

| | Initial eigenvalues | | | Rotation sums of squared loadings | | |
|---|---|---|---|---|---|---|
| Component | Total | % of variance | Cumulative (%) | Total | % of variance | Cumulative (%) |
| 1 | 10.372 | 34.574 | 34.574 | 5.227 | 17.423 | 17.423 |
| 2 | 3.975 | 13.250 | 47.825 | 4.937 | 16.456 | 33.879 |
| 3 | 1.996 | 6.654 | 54.479 | 4.793 | 15.977 | 49.856 |
| 4 | 1.338 | 4.459 | 58.937 | 2.296 | 7.653 | 57.508 |
| 5 | 1.099 | 3.664 | 62.602 | 1.365 | 4.551 | 62.059 |
| 6 | 1.043 | 3.475 | 66.077 | 1.205 | 4.018 | 66.077 |
| 7 | 0.971 | 3.236 | 69.313 | | | |
| 8 | 0.857 | 2.858 | 72.171 | | | |
| 9 | 0.812 | 2.708 | 74.879 | | | |
| 10 | 0.678 | 2.261 | 77.140 | | | |
| 11 | 0.644 | 2.146 | 79.286 | | | |
| 12 | 0.582 | 1.940 | 81.226 | | | |
| 13 | 0.544 | 1.812 | 83.038 | | | |
| 14 | 0.538 | 1.792 | 84.830 | | | |
| 15 | 0.529 | 1.762 | 86.592 | | | |
| 16 | 0.454 | 1.512 | 88.104 | | | |
| 17 | 0.449 | 1.498 | 89.602 | | | |
| 18 | 0.417 | 1.391 | 90.993 | | | |
| 19 | 0.360 | 1.200 | 92.193 | | | |
| 20 | 0.307 | 1.024 | 93.217 | | | |
| 21 | 0.293 | 0.977 | 94.194 | | | |
| 22 | 0.268 | 0.893 | 95.087 | | | |
| 23 | 0.253 | 0.843 | 95.930 | | | |
| 24 | 0.219 | 0.729 | 96.658 | | | |
| 25 | 0.201 | 0.671 | 97.329 | | | |
| 26 | 0.196 | 0.655 | 97.984 | | | |
| 27 | 0.179 | 0.598 | 98.582 | | | |
| 28 | 0.157 | 0.525 | 99.107 | | | |
| 29 | 0.140 | 0.467 | 99.573 | | | |
| 30 | 0.128 | 0.427 | 100.000 | | | |

**Note:** Extraction method: principal component analysis

**Table V.**
Total variance explained

Table VI revealed the principal factor extraction with a varimax rotation conducted on the identified 30 barriers to the incorporation of BIM into QS undergraduate curriculum in Nigeria. The result of analysis grouped the 30 identified barriers into six principal interpretable factors with their components (see Table VI for details).

The six principal factors derived are interpreted as follows:

(1) Factor 1: Scale of culture change.

(2) Factor 2: Lack of enabling environment.

(3) Factor 3: Staff resistance and non-availability of industry expert.

(4) Factor 4: Lack of accreditation standards and requirements.

(5) Factor 5: High cost of implementation. and

(6) Factor 6: High security risk (see Table VI for details).

The six interpretable principal factors are explained as follows:

*Factor 1: Scale of culture change.* This factor accounts for 17.42 per cent (Table V) of the total variance of barriers to the incorporation of BIM into QS undergraduate curriculum. The main components of scale of culture change as a factor include: it is difficult to educate the lecturers due to rapidly evolving technology; disagreement over BIM concept is concerned whether BIM is a methodological process or a software tool; BIM demands new teaching methods; modelling requires expert construction knowledge that is not easily understood by students, especially when they lack work experience; BIM is problematic for people with weak general IT skills; and what to include in BIM course among others (Table VI); these six components have a factor loading: 0.800; 0.731; 0.699; 0.695; 0.667; and 0.655, respectively. This study finding confirms the previous studies that alluded to the fact that the introduction of new processes into an organisation involves the shifting of the culture of the organisation, which involves people, finances, systems and physical resources (Ahmad *et al.*, 2010). Therefore, it is evident from this study finding that the incorporation of BIM into QS curriculum will necessitate dramatic changes among the academic staff and students in the department, and the university at large.

*Factor 2: Lack of enabling environment.* This factor amounts to 16.46 per cent of the total variance of barriers to the incorporation of BIM into QS undergraduate curriculum. The main components are lack of government lead/direction, lack of university management support, lack of IT infrastructure or poor internet connectivity, need to continually upgrade the BIM software and inadequate/erratic power supply (see Table VI for details); these components have a loading: 0.809, 0.789, 0.788, 0.628 and 0.601, respectively. Lack of enabling environment as a factor encompasses the policies and legislations of government and university management towards the incorporation of BIM into the built environment discipline's curricula in higher education. This study confirms the finding by Oladapo (2007) that identified lack of IT infrastructure or poor internet connectivity and inadequate/erratic power supply as constraints to the use of ICT in the Nigerian construction industry. This is not surprising that inadequate/erratic power supply is among the barriers as power supply in Nigeria has been unreliable, which forced all the HEIs in Nigeria to run their own power generating facilities. Currently, these are still a serious challenging issue in Nigeria.

*Factor 3: Staff resistance and non-availability of industry expert.* This factor accounts for 15.98 per cent (Table V) of the total variance of barriers to the incorporation of BIM into QS undergraduate curriculum. The main components include staff resistance/reluctance to initiate new workflow, which BIM software should be taught to the students, ICT literacy of staff or lack of technical expertise, traditional (and current) programme structures and difficulty to appoint industry expert among others (see Table VI for details); these

| Barriers | Component 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| B07. It is difficult to educate the lecturers due to rapidly evolving technology | 0.800 | | | | | |
| B11. Disagreement over BIM concept is concerned whether BIM is a methodological process or a software tool | 0.731 | | | | | |
| B 04. BIM demands new teaching methods | 0.699 | | | | | |
| B 06. Modelling requires expert construction knowledge that is not easily understood by students, especially when they lack work experience | 0.695 | | | | | |
| B 09. BIM is problematic for people with weak general IT skills | 0.667 | | | | | |
| B 10. What to include in BIM course | 0.655 | | | | | |
| B 05. There is a lack of BIM-specific materials and textbooks and other educational resources for students | 0.634 | | | | | |
| B 12. Need for strong fundamental knowledge for the students before being able to undertake BIM | 0.615 | | | | | |
| B 03. There is no room in the existing curriculum for additional classes/courses | 0.602 | | | | | |
| B 13. Need for industry involvement i.e. the need to engage expert industry practitioners in the development and delivery of a BIM curriculum | 0.527 | | | | | |
| B 27. Lack of government lead/direction | | 0.809 | | | | |
| B 25. Lack of university management support | | 0.789 | | | | |
| B 26. Lack of IT infrastructure or poor internet connectivity | | 0.788 | | | | |
| B 20. Need to continually upgrade the BIM software | | 0.628 | | | | |
| B 17. Inadequate/erratic power supply | | 0.601 | | | | |
| B 19. Availability of qualified staff to take BIM course | | 0.581 | | | | |
| B 28. Lack of space and facilities to accommodate BIM | | 0.536 | | | | |
| B 22. Staff resistance/reluctance to initiate new workflow | | | 0.793 | | | |
| B15. Which BIM software should be taught to the students | | | 0.760 | | | |
| B 23. ICT literacy of staff or lack of technical expertise | | | 0.759 | | | |
| B 16. Traditional (and current) programme structures-refers to the typical isolated, discipline-specific programme structure that exists in most universities | | | 0.679 | | | |
| B 29. Difficulty to appoint industry expert | | | 0.606 | | | |
| B 24. Lack of vision of BIM tangible benefits | | | 0.545 | | | |
| B 30. Lack of collaboration with industry expert | | | 0.512 | | | |
| B 14. Resistance to change – difficulty in introducing BIM in an already well-established curriculum | | | 0.443 | | | |
| B 01. There is a lack of accreditation standards and requirements to guide the implementation of BIM within a curriculum | | | | 0.775 | | |
| B 02. Integrating different areas of the curriculum to realise the multidisciplinary aspect of BIM is problematic | | | | 0.667 | | |
| B 08. BIM is resource-intensive | | | | | 0.594 | |
| B 21. Cost of training the staff/lecturers | | | | | 0.562 | |
| B 18. Fear of virus attacks/high security risk | | | | | | 0.570 |

**Note:** [a]Rotation converged in 12 iterations

**Table VI.** Rotated component matrix[a]

components have a loading of 0.793, 0.760, 0.759, 0.679 and 0.606, respectively. This finding is similar to previous studies. For instance, Ruikar *et al.* (2005) asserted that it is very common to experience resistance to the adoption of new technologies and processes from staff. This can be connected with the staff insufficient IT skills among others. This assertion is corroborated by Aouad *et al.* (2006), who identified lack of skilled BIM operatives in the industry as a significant barrier to BIM adoption now in the developing countries.

*Factor 4: Lack of accreditation standards and requirements.* This factor accounts for 7.65 per cent (Table V) of the total variance of barriers to the incorporation of BIM into QS undergraduate curriculum. The factor has two main components: lack of accreditation standards and requirements to guide the implementation of BIM within a curriculum and integrating different areas of the curriculum to realise the multidisciplinary aspect of BIM is problematic; these two components have a factor loading of 0.775 and 0.667, respectively. This study affirmed few of the previous studies that identified inconsistency in the integration of BIM into AEC curricula in higher education (Sabongi, 2009; Becerik-Gerber *et al.*, 2011; Sacks and Pikas, 2013). However, properly structured BIM courses would provide industry-required knowledge to prepare students for successful careers in the industry.

*Factor 5: High cost of implementation.* This factor amounts to 4.55 per cent of the total variance of barriers to the incorporation of BIM into QS undergraduate curriculum. The factor has two main components: BIM is resource-intensive and cost of training the staff/lecturers; these two components have a factor loading 0.594 and 0.562, respectively. This finding is similar to previous studies. For instance, Eadie *et al.* (2015) asserted that implementing BIM necessitates organisations to purchase the pertinent software and hardware and train their staff in the use of that software. It is on this premise that Ayarici *et al.* (2011) found that cost of training and high cost of software are the barriers to BIM adoption in the industry. This is affirmed by Lee *et al.* (2012) that software packages need updates and it is necessary to consider the fact that BIM software packages will periodically need to be updated, which is an added cost.

*Factor 6: High security risk.* This factor amounts to 4.02 per cent of the total variance of barriers to the incorporation of BIM into QS undergraduate curriculum. This factor has only one component, which is fear of virus attacks/high security risk with a factor loading of 0.570 (see Table VI for details). This finding is similar to the ones by previous studies, especially Oladapo (2007), who identified fear of virus attacks as fourth top ranked constraints to the use of ICT in the Nigerian construction industry. In developing countries, this is not surprising as the maintenance of BIM software becomes a serious challenge, which makes BIM software susceptible to virus attacks and other various security risks.

## Conclusions

This study provided empirical evidence on the barriers militating against the integration of BIM into AEC curricula, in this case for QS undergraduate curriculum in the Nigerian Universities. The study identified 30 barriers to the incorporation of BIM into QS undergraduate curriculum. The analysis of the ranking in terms of the total mean score values for the 30 identified barriers revealed that 17 (out of 30) identified barriers scored mean values between 3.58 and 4.01, which are considered as serious barriers. It can be deduced from this study that there are more serious barriers influencing the integration of BIM into QS undergraduate programme in Nigerian universities.

In addition, the top ten ranked barriers are as follows: lack of IT infrastructure or poor internet connectivity; BIM is resource-intensive; lack of government lead/direction; cost of training the staff/lecturers; availability of qualified staff to take BIM course; the need to continually upgrade the BIM software; lack of accreditation standards and requirements to guide the implementation of BIM within a curriculum; inadequate/erratic power supply; lack of collaboration with industry expert; and BIM is problematic for people with weak general IT skills. The results of Mann–Whitney test indicated a very slight statistically significant difference on 4 and 5 (out of 30) identified barriers on perceptions of the respondents at OAU and FUTA, respectively. This little significant difference is not surprising because it could be connected with their lived experience of the respondents about the BIM concepts in relation to the existing infrastructure in their respective university and their familiarity with QS practices in the industry.

The study, through factor analysis, grouped the 30 identified barriers to BIM incorporation into QS programme into six major factors: scale of culture change; lack of enabling environment; staff resistance and non-availability of industry expert; lack of accreditation standards and requirements; high cost of implementation; and high security risk. This study is not without limitations. For instance, the respondents considered in this study were from two universities fully accredited by both the National Universities Commission and the Quantity Surveyors Registration Board of Nigeria in southwestern Nigeria. Considering other accredited universities offering QS programme in Nigeria would have enhanced the credibility of the findings. Also, the use of questionnaire survey allows a large sample to be captured; having other methods together such as interviews may enrich the findings. Despite the limitations, the findings of this study provide greater insights and empirical evidence on the major barriers that both academia and students need to overcome to successfully incorporate BIM into a curriculum. The findings would be of great value to academic staff and university management to develop strategies for incorporating BIM into AEC disciplines curricula in developing countries at large. Further, the barriers identified in this study are relevant to not only QS profession but also other related disciplines within the AEC industry.

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**Corresponding author**
Solomon Olusola Babatunde can be contacted at: sobabatunde80@gmail.com

# Collaborative multi-disciplinary learning: Quantity surveying (QS) students' perspective



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| Abstract: | The construction industry is highly fragmented and is known for its adversarial culture, culminating in poor quality projects not completed on time or within budget. The aim of this study is thus to guide the design of QS programme curricula in order to help students develop the requisite knowledge and skills to work more collaboratively in their multi-disciplinary future workplaces.<br>A qualitative approach was considered appropriate as the authors were concerned with gathering an initial understanding of what students think of multi-disciplinary learning. The data collection method used was a questionnaire which was developed by the Behaviours4Collaboration (B4C) team.<br>Knowledge gaps were still found across all the key areas where a future QS practitioner needs to be collaborative (either as a project contributor or as a project leader) despite the need for change instigated by the multi-disciplinary (BIM) education revolution.<br>The study concludes that universities will need to be selective in teaching, and innovative in reorienting, QS education so that a collaborative BIM education can be effected in stages, increasing in complexity as the students' technical knowledge grows. This will help students to build the competencies needed to make them future leaders. It will also support programme currency and delivery. |

# Collaborative multidisciplinary learning: Quantity surveying students' perspectives

**Authors:**

**Damilola Ekundayo**
University of Salford, UK

**Mark Shelbourn**
Birmingham City University, UK

**Solomon Olusola Babatunde**
Obafemi Awolowo University, Nigeria

**Corresponding author:**

Damilola Ekundayo, School of Science, Engineering and Environment, University of Salford, The Crescent, Salford M5 4WT, UK. Email: d.o.ekundayo@salford.ac.uk



**Abstract:**

The construction industry is highly fragmented and is known for its adversarial culture, culminating in poor quality projects not completed on time or within budget. The aim of this study is thus to guide the design of quantity surveying (QS) programme curricula in order to help students develop the requisite knowledge and skills to work more collaboratively in their multidisciplinary future workplaces. A qualitative approach was considered appropriate as the authors were concerned with gathering an initial understanding of what students think of multidisciplinary learning. The data collection method used was a questionnaire developed by the Behaviours4Collaboration (B4C) team. Knowledge gaps were still found across all the key areas in which a future QS practitioner needs to be collaborative (either as a Project Contributor or as a Project Leader), despite the need for change instigated by the multidisciplinary revolution in building information modelling (BIM) education. The study concludes that universities will need to be selective in teaching, and innovative in reorienting, QS education so that a collaborative BIM education can be effected in stages, increasing in complexity as the students' technical knowledge grows. This will help students to build the

competencies needed to make them future leaders. It will also support programme currency and delivery.

**Keywords:**

Quantity surveying, collaborative learning, multidisciplinary education, BIM, university curriculum, behaviours for collaboration mapping

The construction industry is changing rapidly due to changing clients' needs, global trends and the gradual introduction of new and disruptive technologies and processes to improve efficiency (Shayan et al., 2019; Celik, 2013). Yet it is widely believed, especially among industry practitioners, that built environment curricula are slow to respond to these changes, as explicated in successive studies (for example: Beckman et al., 1997; McHardy and Allan, 2000; Owusu-Manu et al., 2014 and Palm and Staffansson Pauli, 2018, amongst others). The industry is highly fragmented and is known for its adversarial culture and relationships, culminating in projects not being completed on time, not completed within budget and not adhering to the defined quality criteria or parameters (Wood, 1999; Macdonald and Mills, 2013).

Indeed, the process of designing, constructing and maintaining a building or facility requires several individuals and built environment professionals working together to achieve the desired project outcomes. Such professionals include architects, architectural technologists, engineers, quantity surveyors and construction project managers. Macdonald and Mills (2013) strongly argue that integrated project delivery employing collaboration and disruptive technologies (such as BIM) have the potential to enhance collaboration between these various groups of stakeholders and to improve efficiency in the industry (which is lagging behind other sectors, such as the manufacturing industry). Thus, the education of practitioners to this end has never been so important and worthy of further investigation (Scott, 2015; Scott, 2016; Babatunde et al., 2018; Beckman et al., 1997; Palm and Staffansson Pauli, 2018).

Built environment graduates, particularly the quantity surveyors of the future, will need to be highly technical, adaptable, good communicators and also lifelong learners undertaking continuing professional development (CPD). This is the view of many proponents in this field, including Nkado and Meyer (2001); Male (1990); Yogeshwaran et al. (2018); Shafie et al. (2014); and Perera et al. (2013). Such a goal provides the modern academic with many challenges. Commentators suggest that the current model of pedagogy, which is at the heart of the current higher education experience, is becoming obsolete (Scott et al., 2013; Scott, 2015). In the industrial model of student mass production, the teacher is the broadcaster. However, we hear calls for more constructivist learner-centred approaches. A multidisciplinary learning approach has the potential to create the opportunity to develop the skills, competences and understanding that graduates now require (Wood, 1999; Soetanto et al., 2012; Macdonald and Granroth, 2013; Puolitaival and Kestle, 2018). A holistic, multidisciplinary approach to the design, construction, production and operation of buildings is likely to require changes in the way the process is arranged, resourced and managed in the future. There will be a different kind of professional in the next five years, whose education and/or training will need to enable them to make the many connections in thinking and take the actions required to solve complex problems in a digital age (Shayan et al., 2019; Özorhon and Karaciğan, 2020).

Future built environment professionals will challenge the conventions of the past and will use their creative and innovative capacities. From a learning front engaged with digital technology, it is now possible to embrace new collaboration models that change the paradigms in fundamental ways (Özorhon and Karaciğan, 2020; Bryde et al., 2013; Georgiadou, 2019; Stanley and Thurnell, 2014). But this pedagogical change is not about technology per se; nor is it about distance learning, or the ability of students to access lectures by some of the world's leading professors from free online sites; rather, this represents a change in the relationship between student and teacher in the learning process. The assessment of the learning in such an approach is easily measured from the academic's perspective; teachers will observe students grow in confidence, understanding and knowledge as they experience a positive constructivist learning engagement. By becoming a 'guide on the side' educator, a teacher can provide the motivation and appetite for future innovation.

This paper offers reflections on a collaborative multidisciplinary learning project at a university in the North West region of the UK, undertaken by students of architecture, architectural technology, building surveying, construction project management, quantity surveying (QS) and real estate and property management. This paper concentrates on the QS perspective and is concerned with gathering students' perceptions of multidisciplinary learning. The continued support of multidisciplinary learning at the selected university is seen as vital to the creation of future leaders in the built environment. The concept of sampling students to develop an understanding of an existing phenomenon to better improve academic practice in a constructivist learner-centred approach in the built environment is not new (see Babatunde et al., 2018; Babatunde and Ekundayo, 2019). Additionally, this approach was used in Shelbourn et al. (2017) to gather students' perceptions of BIM education.

A qualitative approach, using the initially developed Collaborative Behavioural Map, was considered appropriate for this study as the authors were concerned with gathering a preliminary understanding of what students thought about their multidisciplinary education in an academic environment. The study aim is thus to guide the design of QS programme curricula in order to help students develop the requisite knowledge, skills and competencies to work more collaboratively; that is, to acquire the behaviours badly needed in their multidisciplinary future workplace. It is intended that the findings will be used in programme team meetings to facilitate discussions regarding the behaviours that can be used to coach students to develop a more collaborative style in a constructivist, project-based learning environment.

## Collaborative multidisciplinary team education

McGraw Hill has published several reports on surveys of North American architecture, engineering and construction (AEC) firms concerning their requirements with regard to skills for collaborative BIM. In 2009 they reported that 'more internal staff with BIM skills, more external firms with BIM skills, more incoming entry-level staff with BIM skills and more readily available training in BIM were required to realize the potential value of BIM' (McGraw Hill, 2009: 17). By 2012, the updated report (McGraw Hill, 2012) showed small decreases in the percentages allocated to the collaborative BIM skills required (possibly reflecting uptake by the industry), but collaborative BIM training was still placed among the top three targets for investment by industry.

These reports show similarities with the study by Henderson and Jordan (2009), who suggested that some of the additional skill-sets (in addition to traditional single-discipline learning) required by industry included: '…knowledge of data management, information technology, energy and material conservation, integrated building design, systems thinking, life cycle analysis, the design processes, business and marketing skills, and project finance' (p. 35).

It is the role of educators to instil in students the concepts of collaborative design and the full potential of collaborative team integration, before they learn about the 'old ways' of working once they graduate (Shelbourn et al., 2017). The concept of creating job-ready graduates brings to the fore the 'training versus educating' debate. Gerber et al. (2015) demonstrate that there has been resistance in the past among educators in universities with regard to providing training in collaborative computer technologies as many are unfamiliar with such technologies. This often means that educators expect students to learn appropriate technologies themselves, as they do many other software applications (Williams et al., 2009). Given these precedents, one can assume the same approach to learning for collaborative BIM, meaning that students will tend to focus on the technological aspects rather than on developing an understanding of how BIM principles and processes could enable them to work more effectively with others in a collaborative team environment.

With regard to the training versus education debate, many educators still view BIM as just another piece of computer-aided design (CAD) software that students should learn in their own time. At the same time, Kocaturk and Kiviniemi (2013), Puolitaival and Forsythe (2016), Underwood and Ayoade (2015) and Woo (2007) assert that the challenges of integrating BIM technologies into academic curricula cannot, and should not be, underestimated. Irrespective of the pedagogical challenges, many argue that it is not the university's role to produce 'CAD technicians' and that there is little educational value in using CAD, or that CAD threatens creativity (Becerik-Gerber et al., 2011). These concerns may be justified as the adoption of computers and 2D CAD has coincided with a decrease in documentation quality and productivity (Engineers Australia, 2005). However, collaborative BIM is not merely a new CAD tool or a computer application: it is a new paradigm and its benefits extend much further than 3D drafting (Chegu Badrinath et al., 2016). Students cannot be expected to teach themselves BIM any more than they can be expected to teach themselves structural engineering (Engineers Australia, 2005; Gledson et al., 2016). From a learning point of view, there is little difference between learning manual drafting techniques and learning 2D or 3D CAD. However, with collaborative BIM, every part of the design and construction process can be compared, with building performance also modelled at this stage and monitored in the operational phase. Both 2D and 3D CAD merely provide a way of documenting information about the building, whereas collaborative BIM actually represents the building virtually with critical information contained within it to help optimise the operation of the facility throughout its life cycle (Hu et al., 2017).

In addition to the resistance to using new technologies in teaching, the faculties in which this learning is taking place can also be a barrier to learning, as shown by Kocaturk and Kiviniemi (2013) and reinforced by Shelbourn et al. (2016). Since engineering and architecture emerged as separate professions from the historical job title of 'Master Builder', students of the different disciplines have tended to be educated in isolation from each other. According to Pressman (2007: p. 3):

> 'Many academic programs still produce students who expect they will spend their careers working as heroic, solitary designers. But integrated practice is sure to stimulate a rethinking of that notion. Pedagogy must focus on teaching not only how to design and detail, but also how to engage with and lead others, and how to collaborate with the professionals they are likely to work with later.'

Starzyk and McDonald (2010) identified a focus in architectural education on developing individual skills, such as the ability to draw. They have also noted that the importance of personal skills is yielding to the primacy of collective knowledge. Scott (2015) found little or no integration or collaboration between the disciplines in the majority of universities in the USA, Europe and Australia. Moreover, the first time students are exposed to working with team members from other disciplines is in the workplace, post-graduation. Shelbourn et al. (2017: 295) discuss this further and argue that '…it is important for graduates to have an understanding of the roles played by other professionals and the impact their decisions have on projects overall'. However, the lack of multidisciplinary collaborative learning means that students are not provided with such an understanding in many current curricula across these countries.

Another issue to consider is the complexity of modern building projects and the technologies used in their design and construction: such complexity means that nobody can be a master of all. Students learning in their silos lack a deep understanding of the information that is required at different stages of a project (Shelbourn et al., 2017). What is required is for students to work collaboratively and to learn the requirements of the other disciplines before they graduate, often in multidisciplinary modules, projects and even student competitions such as those offered as part of the Associated Schools of Construction in the USA.

The problem is not restricted to learning in disciplinary silos; different departments are often in separate schools or faculties and can be located on separate campuses (Shelbourn et al., 2016). Sharing learning across the different silos is a challenge that needs to be addressed if graduates are to leave their studies with the key understanding of the importance of collaboration (Shelbourn et al., 2016). The need for change instigated by the BIM revolution (Cabinet Office, 2011) provides a great opportunity to rethink how teaching and learning are designed, according to Shelbourn et al. (2017). This view is shared in the later studies by Babatunde et al. (2018), Puolitaival and Kestle (2018) and Babatunde and Ekundayo (2019).

Continuing the more positive note, Hardy, quoted in Deutsch (2011: p. 202) stated, 'When I look at the logic of construction means and methods that collaborative BIM inherently teaches, I see the potential to educate.' Nawari (2010: 312) noted that 'students need to know how each discipline is related to the other and how one discipline impacts the other'. Collaborative BIM can offer a better opportunity, therefore, to engage students more effectively and to help with their understanding of how buildings are constructed.

Mark et al. (2001) proposed an 'ideal computer curriculum' for architectural education in which computing technologies were added to the existing curriculum without removing or adding subjects. Mark et al. (2001) offered two alternative approaches: one that merged technology into the traditional curriculum, and the other a more radical approach that displaced some existing subjects. The proposal was limited to teaching BIM modelling for visualization or analysis within the architectural discipline alone. Scott (2016: p. 552) highlighted the case for setting education in the pragmatic paradigm, pointing out that 'the freedom to work within the pragmatic paradigm offers diversity that can draw together some of the thoughts that challenge and build the arguments about the role and position of theory in construction education' – a useful consideration when looking at collaborative multidisciplinary education.

The global construction industry is witnessing a move towards a more collaborative way of working with the growing awareness of, and implementation of, BIM – see Bryde et al. (2013), Zainon et al. (2016); Ghaffarianhoseini et al. (2017), Vass and Gustavsson (2017) and Özorhon and Karaciğan (2020). Team learning, typical of multidisciplinary BIM education, has been seen as a way of achieving competence-based education, especially in vocational studies such as built environment disciplines. In the opinion of Wijnia et al. (2016) and many others, students' involvement in collective team learning activities is crucial to the development of the necessary knowledge, skills and competencies. Zhao et al. (2013) referred to this as BIM-enhanced team-based learning, an approach considered capable of meeting future needs and industry's expectations of new construction graduates. In other words, the incorporation of BIM into construction education is expected to improve collaboration and multidisciplinary working in the industry.

The challenge for academics wanting to educate undergraduates so that they can work effectively in collaborative teams, putting together virtual (and eventually real-life) buildings, is *when* and *how* to introduce elements of multidisciplinary knowledge, BIM technologies and the development of team working skills. Collaborative, multidisciplinary education should be effected in stages (Shelbourn et al., 2016), increasing in complexity as the students' knowledge of the building design and construction process grows (Gordon et al., 2009).

## Research methodology

This study was concerned with gathering students' perceptions of multidisciplinary learning. A qualitative approach was considered appropriate as the authors wanted to obtain an initial understanding of what students thought of their multidisciplinary education in an academic environment. The data collection method was a questionnaire. The researchers were not looking for the reasons why the participants chose what they did with regard to working collaboratively, but were more interested in what they thought at that moment. The questionnaire used was developed by the Behaviours4Collaboration (B4C) team, which came together from research carried out at the University of the West of England in Bristol, UK. The B4C team is made up of academics, built environment professionals, and human resource management professionals who have a vested interest in improving multidisciplinary collaborative practices and productivity in projects. The team has been in existence since 2011 and is currently working closely with the UK BIM Task Group, the Centre for Digital Built Britain (CDBB), and Transforming Construction Network Plus in defining the Pedagogy and Upskilling research agenda. Digital Built Britain is the next phase of implementing BIM in the industry and is the new name for Level 3 BIM in the UK.

The participants were all enrolled in a multidisciplinary module at a North Western University in the UK. This module is a level 5 module (year 2 of the undergraduate degree) and at the time of the survey 207 students were enrolled in it. There were responses from 12 students in Architectural Design Technology, 10 in Architecture, 8 in Building Surveying, 10 in Construction Project Management, 6 in Property and Real Estate Management and 29 in Quantity Surveying. This paper discusses the findings from the responses from the QS students who completed the questionnaire.

## The B4C Map

The B4C team designed and developed the Collaborative Behaviours Map through several workshops, which included representatives from both industry and academia. As can be seen from Figure 1, the map consists of various levels on the left-hand side depicting differing levels of maturity of collaborative behaviour. Across the top of the map are roles people can hold in the architecture, engineering and construction industries:

- A 'Project Contributor' is any person who undertakes a role in a project, including sub-contractors.
- 'Project Leaders' are those who take on a leading role during the project. The Project Leader is likely to change as the project progresses through its different phases.
- A 'Group Leader' leads a part of an organisation, for example a sector, service, department or area, and has impacts wider than the project although is not leading the organisation.
- The 'Organisation Leader' leads the organisation at a strategic level and sets the tone for the organisation in all aspects of its business.
- The 'Industry Leader' is recognised by peers in the industry as someone who has to lead a number of initiatives to move the industry forward at the policy making level.

Each of these roles signifies a different level of responsibility in the industry. It was determined in the workshops that these different roles would require a different level of collaborative behaviour. The roles listed above were discussed at some length in the workshops held to develop the behavioural map.

The workshops also determined that there were several key areas for which 'collaborative behaviours', as defined by the B4C team, were needed. Figure 2 shows these different behaviours.

Figures 1 and 2 about here

The aim of the map is to guide and advise an array of professionals on how to develop their behaviours to work more collaboratively. It is the intention of the B4C team that the map should be used in team meetings to facilitate discussions about the behaviours that can be used and to coach individuals to develop a collaborative style. When users look at the higher levels of maturity it is hoped that they will assume that the lower levels are also necessary (although they may not be present); therefore, the behaviours are cumulative as the levels of maturity increase. The same is also true for the behaviours applying to specific roles; those behaviours specified for the Project Contributor are also required for the Industry Leader. It should be borne in mind that these behaviours need examining within each individual using the map.

The B4C map was adapted for the purposes of the research discussed in this paper. As the participants were level 5 undergraduate QS students it was decided by the research team that the descriptors of 'Group Leader', 'Organisation Leader', and 'Industry/Subject Leader' would be removed, making the map simpler for them to complete. Data were collected during a scheduled teaching tutorial at the university in the 'Project Contributor' and 'Project Leader' sections, and the results from these sections are discussed in the paper. The participants were given a brief introduction to the B4C map and why the research was being conducted. Ethical considerations were given high priority, so that all the participants were fully aware of the reasons for the data collection.

# Findings and discussion

As already noted, the data for the study were collected through the administration of the B4C map to level 5 undergraduate QS students in a university in the North West of England. The university has one of the largest multidisciplinary schools of the built environment in the UK. The map was administered to students taking the multidisciplinary project (MDP) module. This module is undertaken by different disciplines in the school, including Architecture; Architecture, Design and Technology; Building Surveying; Construction Project Management; Property and Real Estate; and Quantity Surveying. However, this study focuses on the QS students' perspectives of collaborative multidisciplinary learning.

The MDP module aims to provide students with an opportunity to work in multidisciplinary teams and to enable them to perform in a role/discipline in the context of a team-based project. The project is always defined by an industrial organisation that works closely with the Built Environment (BE) School. The module is designed to promote reflection on individual and team working and the multidisciplinary nature of built environment (BE) projects, so that students are encouraged to practise and further develop both the discipline-based and the generic key skills required by a BE professional, including collaborative working and interpersonal skills.

In all, 29 fully completed responses were received from the QS students, all of which were found suitable for analysis. The B4C maps were hand-delivered to the QS students present at the MDP module session. Based on the different roles students had assumed in previous projects set in the MDP module, when they had to work with other disciplines, they were guided through the completion of the map by engaging in detailed reflection on the key collaborative behaviours and differing maturity levels. This detailed guidance helped to achieve a high response rate of almost 100%.

Descriptive statistics were conducted for the analysis (techniques used included frequencies and percentages). Percentages were used to indicate the maturity level(s) of the respondents in each of the identified collaborative behaviours. Table 1 shows the results of the collaborative behavioural mapping. Additionally, graphs depict where the respondent's strength lies, either as a Project Contributor and/or a Project Leader, at differing levels of maturity of collaborative behaviour.

Figures 3–6 show a general pattern in the behaviours of QS students with regard to working collaboratively. As indicated in Figure 1, maturity level 0 typifies non-collaborative behaviour. However, none of these students saw themselves at this level, which begs the question of why projects are not always successful. Similarly, most students saw themselves at the upper end of the scale, as can be seen in the graphs which show a gradual increment in the maturity level of collaborative behaviour. Since the behaviours are cumulative as the levels of maturity increase, the gradual increment is to be expected. The only exception is the issue of trust/respect; QS students as Project Contributors prefer to be seen as communicating necessary information (indicative of maturity level 1) and not allowing distraction (typical of maturity level 2). This is logical, as a lower level of maturity may be considered attractive if it relates more to the primary role and responsibilities of a quantity surveyor.

Table 1 and figures 3–6 about here

It can be seen from Figure 7 that QS students as Project Contributors accord more emphasis to trust/respect at maturity level 1 than to any other collaborative behaviour – perhaps because of the need for quantity surveyors to be seen as trustworthy from the outset to reinforce their authority when working as part of a project team, advising on costs and contractual matters.

Openness/communications and interdependent goals/new ways of working followed as joint second, while the leadership/interpersonal impact factor was seen as less of a necessity at maturity level 1: however, as the maturity level increased this factor became more important, especially to achieve the project objectives. Similarly, trust/respect and openness/communications are key to achieving project objectives and so show a similar trajectory. Whilst interdependent goals/new ways of working might be gaining momentum at the lower maturity levels, it became relatively stable at the highest level when other collaborative behaviours are much needed and/or desired.

Figures 7 and 8 about here

Figure 8 shows the collaborative behaviours of QS students as Project Leaders. At maturity level 1, most students perceived that trust/respect was far more important to a Project Leader than in any other key area in which they needed to be collaborative. Openness/communication and interdependent goals/new ways of working followed in second position while the leadership/interpersonal impact factor was not present. At maturity level 2 though, the leadership/interpersonal impact factor was considered most important, while openness/communication was considered the least relevant of the four collaborative behaviours. Similarly, at maturity level 3, the leadership/interpersonal impact factor was perceived to be the most important, whilst at level 4 the remaining three collaborative behaviours prevailed. It is reassuring to know that students understood that trust/respect are key collaborative behaviours and a must-have for any Project Leader no matter the maturity level, as well as openness/communications and setting interdependent goals/new ways of workings in equal measure.

As shown in Figure 9, QS students see themselves more as Project Contributors than as Project Leaders. This is evidenced at the various maturity levels except for level 3, where some believed they should be seen more as Project Leaders. The views of the students are consistent with the thinking of the B4C team in that the person undertaking the Project Leader role is likely to change from time to time. Whilst quantity surveyors may perform the role of a cost estimator on a project, they may also be required to take a leading role, for example, in contract administration and the overall cost management of a project from inception to completion. This is when a quantity surveyor may assume the role of a Project Leader rather than simply acting as a Project Contributor.

Figure 9 about here

As the results show, the QS students believed they were mostly collaborative, as either Project Leaders or Project Contributors, in all the key areas identified. In fact, none of them thought they exhibited non-collaborative behaviours, although this is open to debate and interpretation. It would be interesting to see what students of other disciplines think of the maturity levels of QS students in the key areas in which they need to be collaborative. Also of interest is the collaborative behaviour of other professionals in the built environment and how they compare with each other.

According to the literature, a lack of multidisciplinary collaborative learning in most BE curricula and a lack of integration between the disciplines in BE schools are issues that most participants in the education versus training debate are keen to see resolved (Scott, 2015; Shelbourn et al., 2017; Starzyk and McDonald, 2010). At face value, it appears that the MDP module is providing QS students with the opportunity to develop the necessary skills through collaborative multidisciplinary learning and by working with team members from other disciplines. Further research is required to ascertain the true effect of this positive development in the workplace post-graduation.

Table 1 shows the different roles that a quantity surveyor can assume in the construction industry and the different levels of collaborative behaviour attainable. It is worth noting that approximately half of the respondents are still below maturity level 4 and are not as collaborative as they could be. Though the behaviours are cumulative as the levels of maturity increase, other key areas in which a person needs to be collaborative as a Project Leader or a Project Contributor are not present in nearly half of the students. This is a rather disturbing finding in light of the importance of collaboration and team working skills in the construction industry. These are the people who will be required to collaborate with other professionals in the future to help us build and maintain the built and natural environments.

The results of this study, therefore, affirm the findings of Pressman (2007) and Nawari (2010) concerning the challenge for academics of teaching future BE professionals how to engage with and lead others so they can work effectively in teams. There is a growing need for pedagogy to focus on multidisciplinary collaborative BIM education if we are to produce graduates with the necessary skills. Integrating the B4C map into the BE curriculum may help to facilitate teaching of the behaviours needed to develop a collaborative approach and to equip our future BE professionals accordingly.

## Conclusions and future research

Collaborative multidisciplinary learning has become an inevitable trend in recent years due to the need for academics to educate undergraduates so they can work effectively in collaborative teams, putting together virtual (and eventually real-life) buildings and capable of taking care of our built and natural environments. Collaborative education has gained in popularity and momentum in BE/AEC curricula in the UK and abroad because of the industry's requirement for skills for collaborative BIM, the need for collaborative BIM training (which is a top priority for investment by industry), and the changing role of educators in creating job-ready graduates.

The complexity of modern building projects and the technologies used in their design and construction mean that students need to work collaboratively and learn the requirements of other disciplines before they graduate, often in multidisciplinary modules and projects. Thus, quantity surveyors, as part of the construction industry, have an important role to play in instigating the necessary changes. This study found that the QS students surveyed were aware of the need to share learning across disciplinary silos, and all respondents exhibited positive behaviours with regard to collaboration, albeit at differing levels of maturity. This demonstrates that the critical role of the university in bringing an understanding of the importance of collaboration to students has been successful. It is also important that the university nurtures these positive attitudes to enable the students to engage in collaborative multidisciplinary learning more wholeheartedly.

The study revealed that the implementation of the multidisciplinary module in the curriculum has been successful to a certain extent in introducing collaborative behaviours holistically. It further showed that students had differing levels of maturity in the key areas they need in order to be collaborative. Several students believed that they showed high levels of maturity in the stated collaborative behaviours and their level of maturity was strongly related to their discipline, even if that discipline only required them to operate at a lower level of maturity. For example, quantity surveyors placed higher importance on 'communicating necessary information' (typical of maturity level 1) than on 'not allowing distraction' (typical of maturity level 2).

Of the identified collaborative behaviours, 'trust and respect' is a key area in which quantity surveyors need to excel, whether working as a Project Contributor or a Project Leader. Trust and respect are seen as the bedrock of any successful collaboration. At maturity levels 1, 2 and 4, students saw themselves as Project Contributors, whilst at maturity level 3 they believed they should be seen more as Project Leaders. Perhaps the only conclusion that can be drawn from these results is that quantity surveyors can work either as a Project Contributor or as a Project Leader, depending on their level of responsibility. The views of the students are consistent with the thinking of the B4C team (which designed and developed the Collaborative Behaviours Map) in that the person undertaking the

Project Leader role is likely to change from time to time. However, knowledge gaps were found across all the key areas for collaboration either as Project Contributor or as Project Leader. Almost half of the students placed a low level of importance on collaborative behaviours despite the need for change instigated by the BIM revolution.

This study has certain limitations. Firstly, considering what other disciplines think of the maturity levels of quantity surveyors in the key areas where they need to be collaborative would have enhanced the credibility of the findings. Secondly, although using a multidisciplinary learning project allows collaborative behaviours to be tested, looking at how the other industry professionals compare with each other may enrich the findings. Despite these limitations, however, the findings of this study may be considered reliable as they are drawn from a fieldwork approach that involved getting students to share their true experiences. Therefore, further research might be conducted involving several universities and AEC firms on a periodical basis, and comparisons could be made to monitor progress in the curriculum and changes in industry's expectations of students' collaborative behaviours. It might also be useful for the university to conduct a survey to ascertain whether the knowledge and skills gained by graduates are relevant to their working careers or are put into actual practice in the workplace after graduation.

These findings show that there is room for improvement amid the continuing training versus education debate in the BE curriculum. A multidisciplinary learning approach can create opportunities to develop the competencies, knowledge and the key understanding of the importance of collaboration that graduates now require. Also, the university should be selective in teaching and innovative in reorienting QS education so that collaborative BIM education can be effected in stages, increasing in complexity as the students' technical knowledge grows. This will help students build the skills, competences and understanding needed to make them future leaders in the built environment.

The study should, therefore, be of value to BE and AEC schools in assisting them to develop a methodology for incorporating a multidisciplinary learning approach into their curricula. The B4C map can be used for mapping understanding of the key skills in the QS curriculum to determine its currency, as demonstrated in this study. Integrating the B4C map into the curriculum in this way will help to establish and facilitate the teaching of the behaviours needed for collaborative work and so to equip our future professionals effectively. The industry will also benefit through using the B4C mapping framework to establish the key skills a graduate quantity surveyor needs in order to be collaborative. Additionally, professional bodies can use the framework developed for regulating professionally-oriented degree programmes in higher education.

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Figure captions

Figures are supplied in separate files (Figs 3-9 in both Word and Excel – please use whichever is best for reproduction.)

**Figure 1.** A sample page from the B4C Collaborative Behavioural Map.

**Figure 2.** The 8 collaborative behaviours devised by the B4C team.

**Figure 3.** Students' knowledge level on the leadership/interpersonal impact factor.

**Figure 4.** Students' knowledge level on openness/communications.

**Figure 5.** Students' knowledge level on interdependent goals/new ways of working.

**Figure 6.** Students' knowledge level on trust/respect.

**Figure 7.** QS students as Project Contributors and the perceived importance of collaborative behaviours.

**Figure 8.** QS students as Project Leaders and the perceived importance of collaborative behaviours.

**Figure 9.** The Collaborative Behavioural Map.

Table 1 is supplied in two separate files (Word and Excel) – please use whichever is best)

## The Collaborative Behavioural Map

Behaviours4Collaboration

### Leadership / interpersonal impact factor

| Maturity / Role | Project Contributor | Project Leader | Group leader | Organisation leader | Industry/ Subject leader |
|---|---|---|---|---|---|
| 4 | Focussed on overall project goals and drivers of others | Seen as an "honest Broker" steering others towards wider goals | Enables and uses creative conflict<br>Helps to overcome unconstructive conflict | Embrace independence<br>Integrity: I do what I say I will<br>Seeks to understand others perspectives | Embrace independence<br>Leveraging opportunities and skills for value<br>Creates joint ownership across the team for all team results |
| 3 | Integrity: I do what I say I will in line with the project goals and drivers of others | Integrity: I do what I say I will.<br>Serving needs of others.<br>Courage- sees conflict as opportunity.<br>Decisions informed by relationships<br>Resilience | Creates interdependent relationships<br>Flags and uses conflict + uncover assumptions | Long term view of rewards<br>Ownership of our actions<br>Resilience- not giving up on agreed goals | Take decisions based on commitment to relationship |
| 2 | Serving needs of others<br>Decisions informed by relationships<br>Seek to understand others perspectives | Aims as our own<br>Values perspectives<br>Engaging others in mutual decisions<br>Identify ways to collaborate for mutual benefit<br>Manages relationships<br>Seek to understand others perspectives | Creates and sustains opportunity to collaborate | Identify ways to collaborate for mutual benefit<br>Engaging others in mutual decisions. | Collective pain and gain mindset.<br>*(maximises the gain for all and/or minimising the pain for all members of a team)* |
| 1 | Aims as our own<br>Ownership of our actions<br>Resilience – not giving up on agreed goals.<br>Can dip in or out of the team | Can revert when the pressure is on to company silos. | Finds opportunities to use individuals skills regardless of role<br>Enables work across silos | Talks of interdependence and initiates dialogue about interdependence | Makes collaboration possible<br>Remove barriers encourage collaboration |
| 0 | Protection of own interests- failure to listen<br>Own aims over those of the team | Protection of own interests- failure to listen | Protection of own/company interests- failure to listen | Protection of company interests | Undermines potential of collaboration by taking a short term view. Closes down possibility for doing things differently. |



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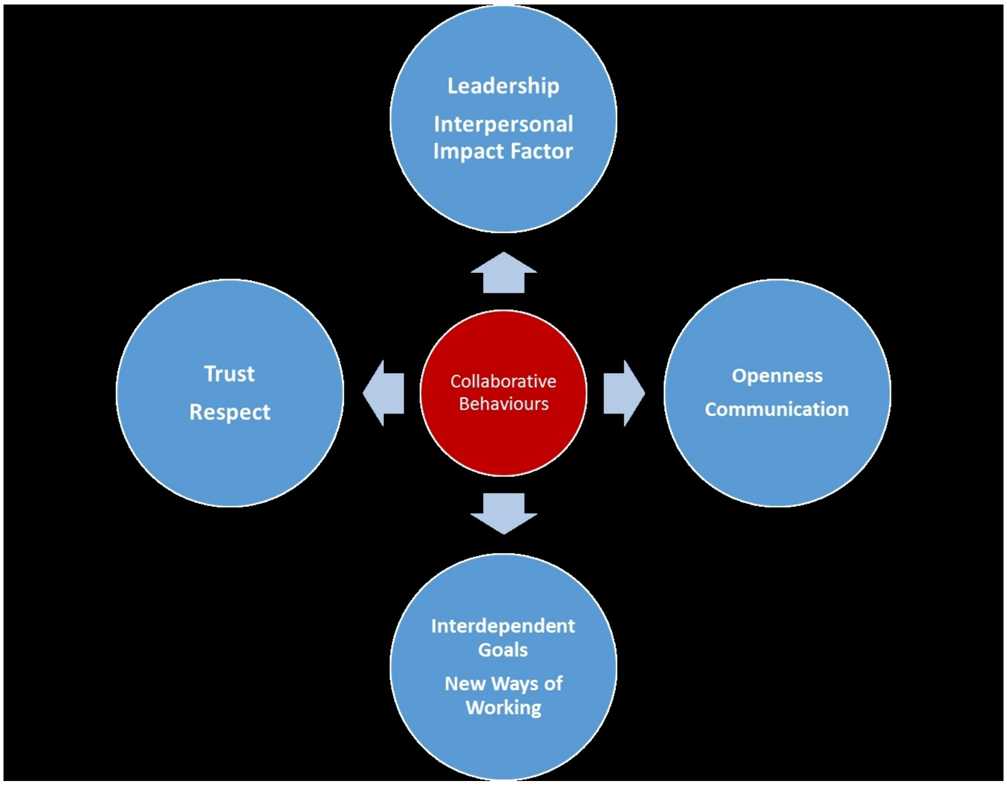


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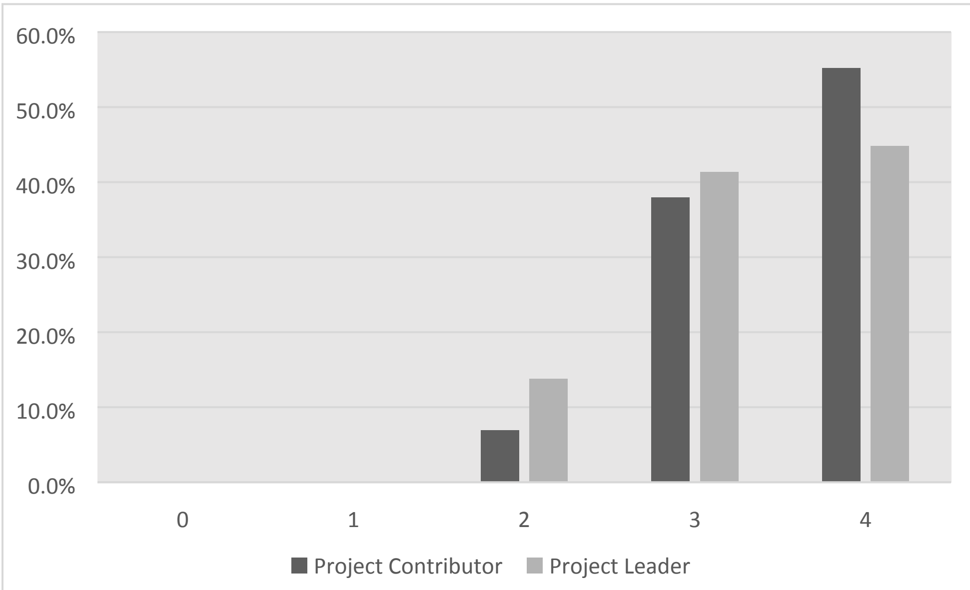
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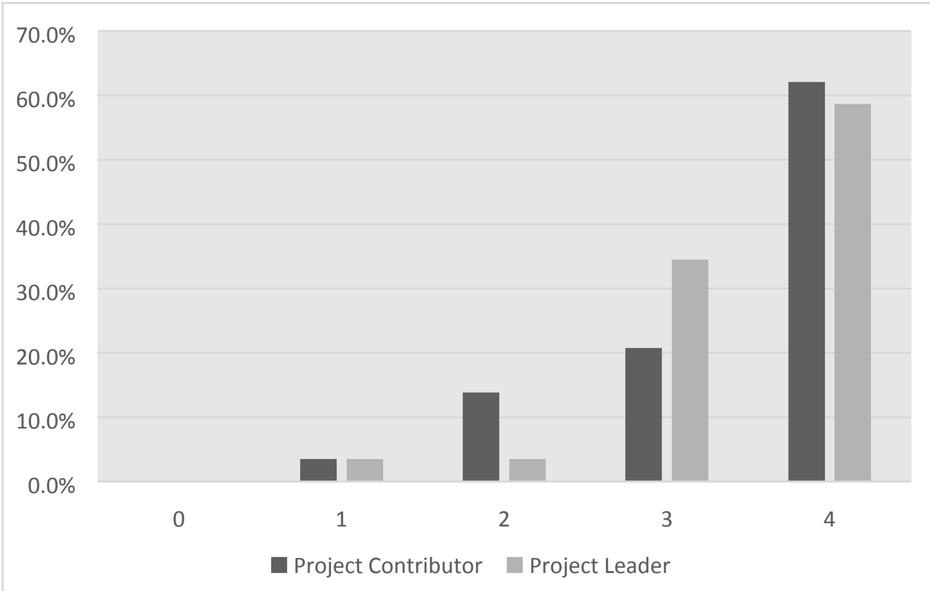
Fig 3.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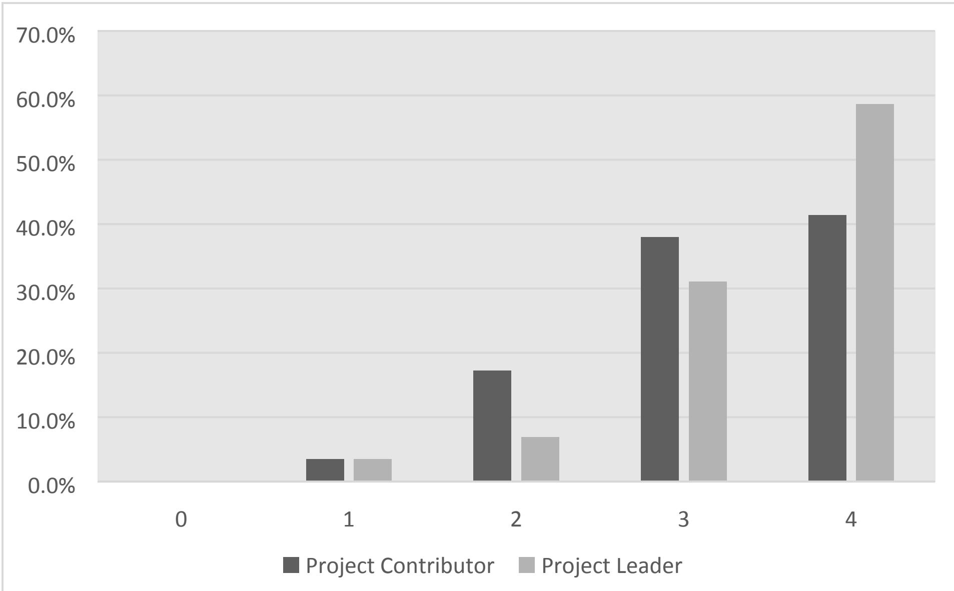
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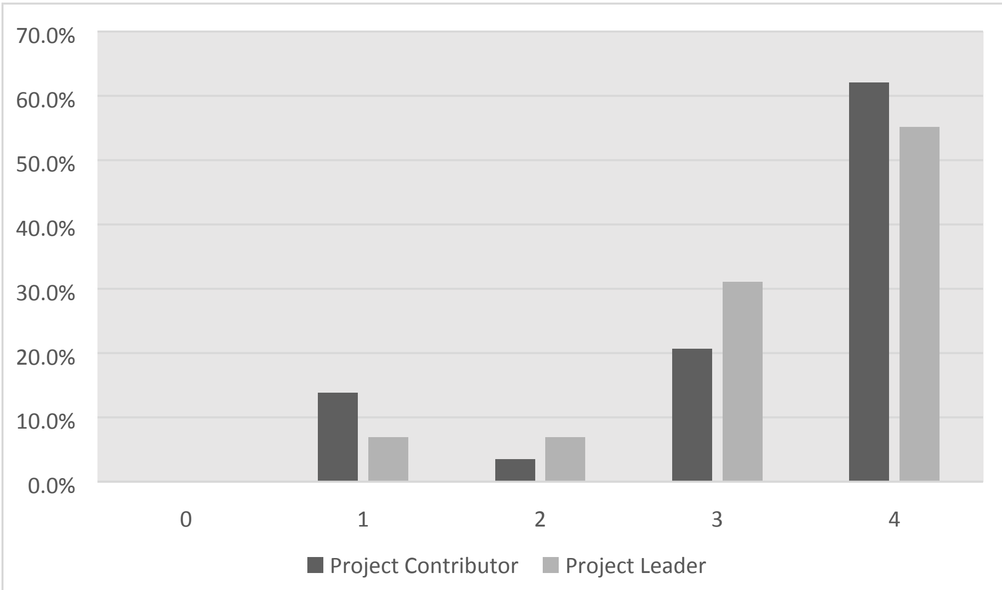
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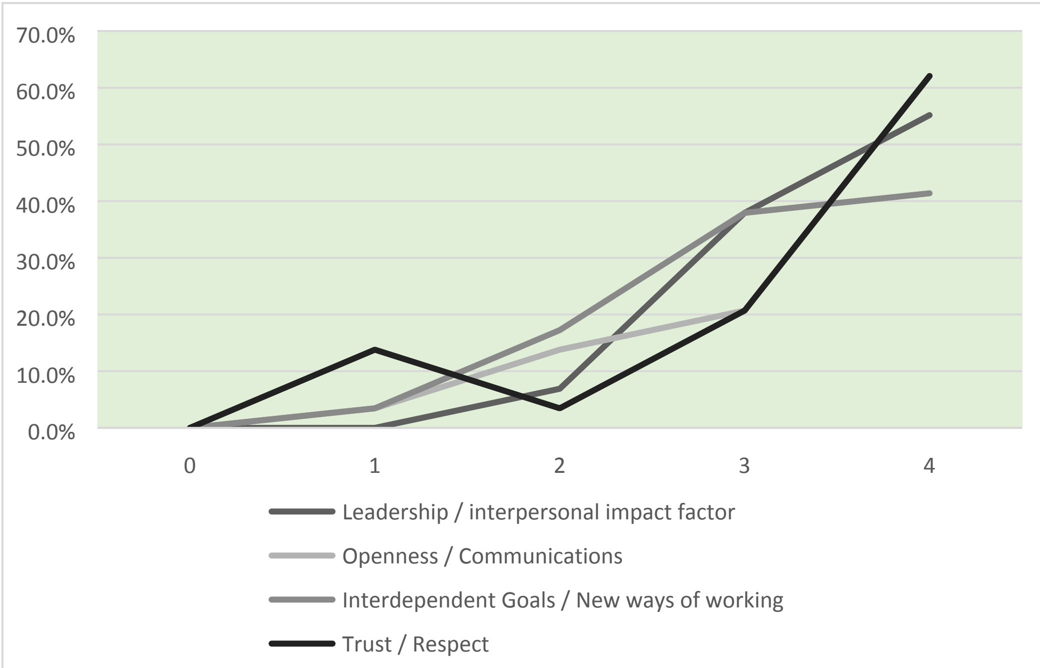
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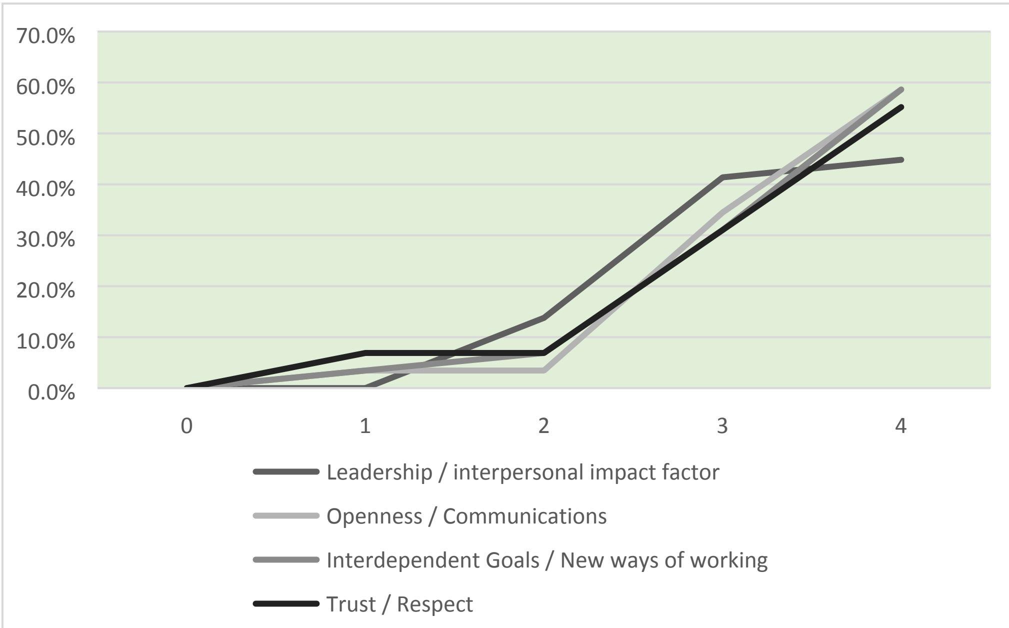
Leadership / interpersonal impact factor
Openness / Communications
Interdependent Goals / New ways of working
Trust / Respect

Fig. 7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Interdependent Goals / New ways of working
Trust / Respect

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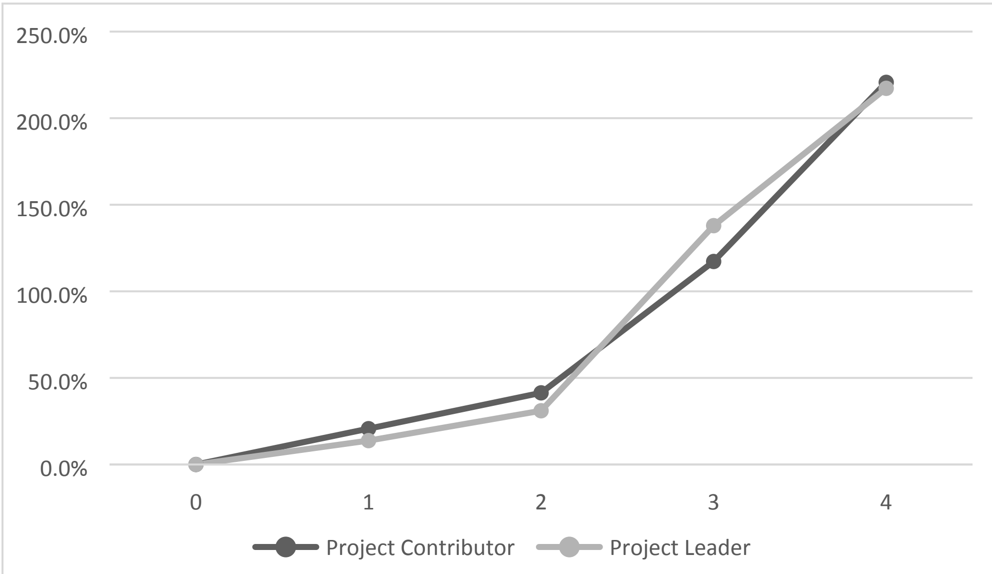
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Project Leader

Fig. 9

| QS | Leadership / interpersonal impact factor | | | | | | | | | | Openness / Communications | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Project Contributor | | | | | Project Leader | | | | | Project Contributor | | | | | Project Leader | | | | |
| | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 |
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| 10E | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
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| 13E | | | | 1 | | | | | 1 | | | | 1 | | | | | 1 | | |
| 13F | | | | 1 | | | | | 1 | | | | | | 1 | | | | | 1 |
| 13G | | | | 1 | | | | | 1 | | | | | | 1 | | | | | 1 |
| 15E | | | 1 | | | | | 1 | | | | | | 1 | | | | | 1 | |
| 16F | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
| 16G | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
| 17F | | | | | 1 | | | | | 1 | | | | | 1 | | | | 1 | |
| 18E | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
| 18F | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
| 20D | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
| 20E | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
| 21D | | | | | 1 | | | | | 1 | | | | | 1 | | | | 1 | |
| 21E | | | | | 1 | | | 1 | | | | | | | 1 | | | | | 1 |
| 23E | | | | 1 | | | | | 1 | | | 1 | | | | | | | 1 | |
| 24E | | | | 1 | | | | 1 | | | | | | | 1 | | | | | 1 |
| 25D | | | | | 1 | | | | 1 | | | | | | 1 | | | | | 1 |
| 26E | | | | | 1 | | | | | 1 | | | | 1 | | | | | 1 | |
| 26F | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 | |
| 31E | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 | |
| 31F | | | | 1 | | | | | 1 | | | | 1 | | | | | | 1 | |
| | 0 | 0 | 2 | 11 | 16 | 0 | 0 | 4 | 12 | 13 | 0 | 1 | 4 | 6 | 18 | 0 | 1 | 1 | 10 | 17 |
| | 0.0% | 0.0% | 6.9% | 37.9% | 55.2% | 0.0% | 0.0% | 13.8% | 41.4% | 44.8% | 0.0% | 3.4% | 13.8% | 20.7% | 62.1% | 0.0% | 3.4% | 3.4% | 34.5% | 58.6% |

| QS | Interdependent Goals / New ways of working | | | | | | | | | | Trust / Respect | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Project Contributor | | | | | Project Leader | | | | | Project Contributor | | | | | Project Leader | | | | |
| | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 |
| 8E | | | 1 | | | | | | 1 | | | 1 | | | | | | | | 1 |
| 10E | | | | 1 | | | | | | 1 | | | | | 1 | | | | | 1 |
| 10F | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
| 10G | | | | 1 | | | | | | 1 | | | | | 1 | | | | | 1 |
| 10H | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
| 11E | | | | | 1 | | | | | 1 | | | 1 | | | | | 1 | | |
| 12E | | | | | 1 | | | | | 1 | | | | 1 | | | | | | 1 |
| 12F | | | | | 1 | | | | | 1 | | | | 1 | | | | | 1 | |
| 12G | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 | |
| 13E | | 1 | | | | | 1 | | | | | 1 | | | | | 1 | | | |
| 13F | | | | | 1 | | | | | 1 | | | | 1 | | | | | 1 | |
| 13G | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
| 15E | | | 1 | | | | | 1 | | | | | | | 1 | | | | | 1 |
| 16F | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
| 16G | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
| 17F | | | | | 1 | | | | | 1 | | | | | 1 | | | | 1 | |
| 18E | | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 |
| 18F | | | 1 | | | | | | | 1 | | | | | 1 | | | | | 1 |
| 20D | | | | 1 | | | | | 1 | | | | | | 1 | | | | | 1 |
| 20E | | | 1 | | | | | | | 1 | | | | | 1 | | | | | 1 |
| 21D | | | | | 1 | | | | | 1 | | | | 1 | | | | | 1 | |
| 21E | | | | 1 | | | | | | 1 | | | | | 1 | | | | 1 | |
| 23E | | | | 1 | | | | | 1 | | | 1 | | | | | | 1 | | |
| 24E | | | | 1 | | | | | 1 | | | | | 1 | | | | | 1 | |
| 25D | | | | 1 | | | | | 1 | | | | | | 1 | | | | 1 | |
| 26E | | | 1 | | | | | 1 | | | | 1 | | | | | 1 | | | |
| 26F | | | | 1 | | | | | 1 | | | | | | 1 | | | | | 1 |
| 31E | | | | 1 | | | | | 1 | | | | | | 1 | | | | | 1 |
| 31F | | | | 1 | | | | | 1 | | | | | | 1 | | | | 1 | |
| | 0 | 1 | 5 | 11 | 12 | 0 | 1 | 2 | 9 | 17 | 0 | 4 | 1 | 6 | 18 | 0 | 2 | 2 | 9 | 16 |
| | 0.0% | 3.4% | 17.2% | 37.9% | 41.4% | 0.0% | 3.4% | 6.9% | 31.0% | 58.6% | 0.0% | 13.8% | 3.4% | 20.7% | 62.1% | 0.0% | 6.9% | 6.9% | 31.0% | 55.2% |

| | Number | % |
|---|---|---|
| Quantity Surveyor | 29 | 100.0% |

**Figure 3. Students' knowledge level on leadership / interpersonal impact factor**

| **Maturity Level** | 0 | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| **Project Contributor** | 0.0% | 0.0% | 6.9% | 37.9% | 55.2% | **100.0%** |
| **Project Leader** | 0.0% | 0.0% | 13.8% | 41.4% | 44.8% | **100.0%** |

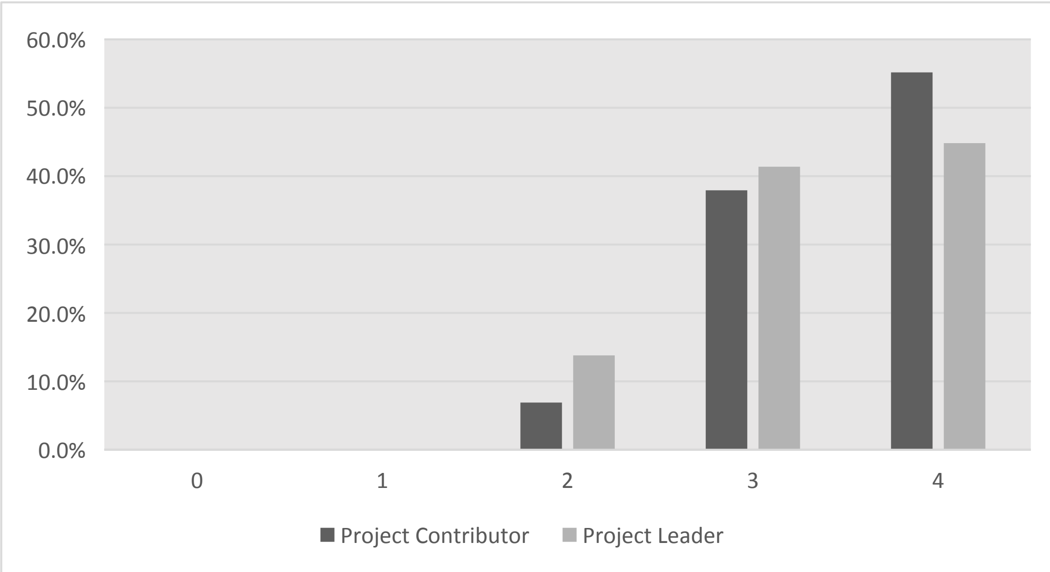
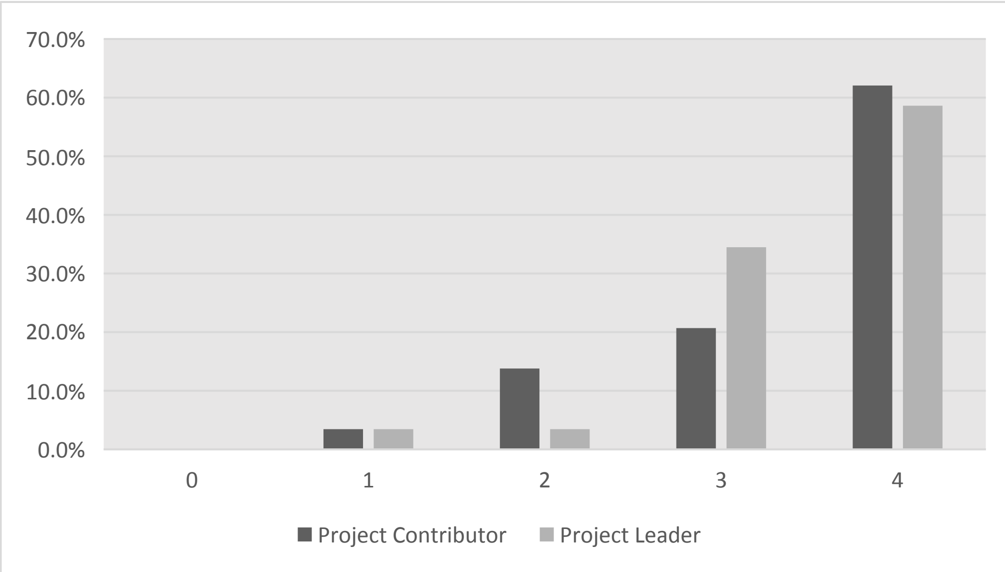


**Figure 4. Students' knowledge level on openness / communications**

| Maturity Level | 0 | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| **Project Contributor** | 0.0% | 3.4% | 13.8% | 20.7% | 62.1% | **100.0%** |
| **Project Leader** | 0.0% | 3.4% | 3.4% | 34.5% | 58.6% | **100.0%** |



| | Number | % |
|---|---|---|
| Quantity Surveyor | 29 | 100.0% |

**Figure 5. Students' knowledge level on interdependent goals / new ways of working**

| **Maturity Level** | 0 | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| **Project Contributor** | 0.0% | 3.4% | 17.2% | 37.9% | 41.4% | **100.0%** |
| **Project Leader** | 0.0% | 3.4% | 6.9% | 31.0% | 58.6% | **100.0%** |

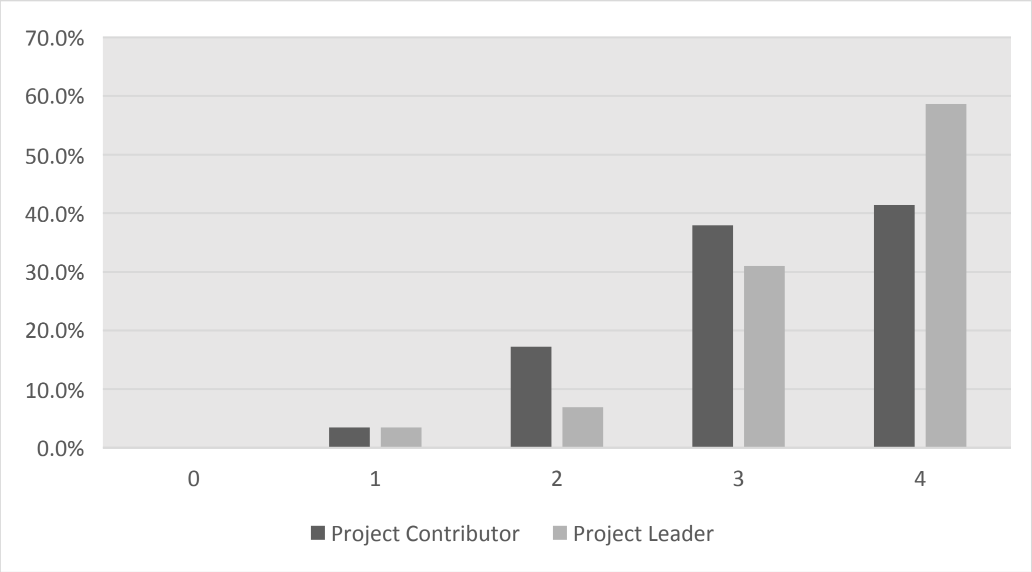


**Figure 6. Students' knowledge level on trust / respect**

| Maturity Level | 0 | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| Project Contributor | 0.0% | 13.8% | 3.4% | 20.7% | 62.1% | **100.0%** |
| Project Leader | 0.0% | 6.9% | 6.9% | 31.0% | 55.2% | **100.0%** |

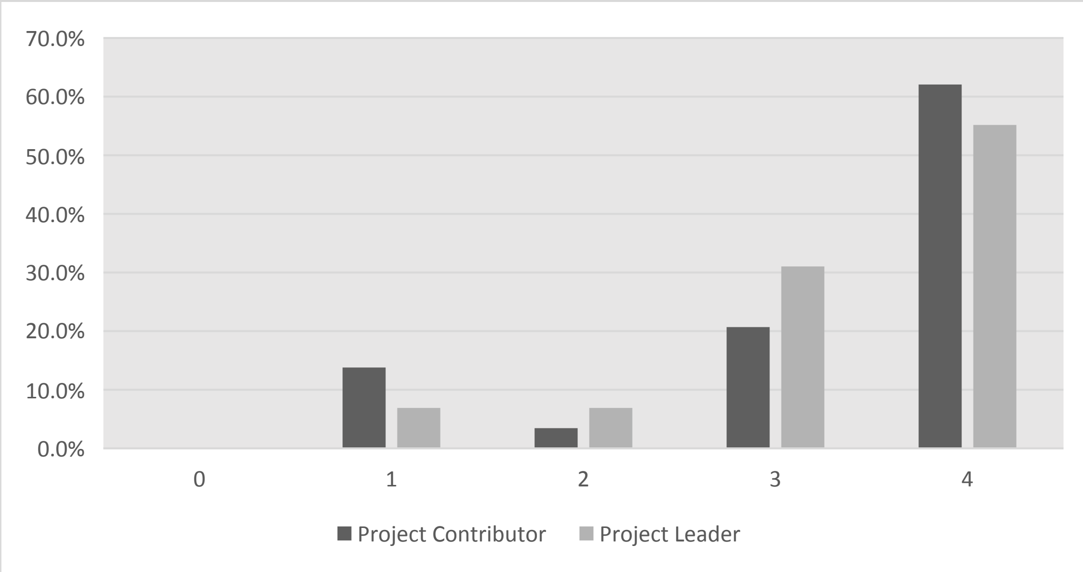


**Figure 7. QS students as project contributors and perceived importance of collaborative behaviours**

| **Maturity Level** | 0 | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| Leadership / interpersonal im | 0.0% | 0.0% | 6.9% | 37.9% | 55.2% | **100.0%** |
| Openness / Communications | 0.0% | 3.4% | 13.8% | 20.7% | 62.1% | **100.0%** |
| Interdependent Goals / New | 0.0% | 3.4% | 17.2% | 37.9% | 41.4% | **100.0%** |
| Trust / Respect | 0.0% | 13.8% | 3.4% | 20.7% | 62.1% | **100.0%** |
| **%** | **0.0%** | **20.7%** | **41.4%** | **117.2%** | **220.7%** | **400.0%** |

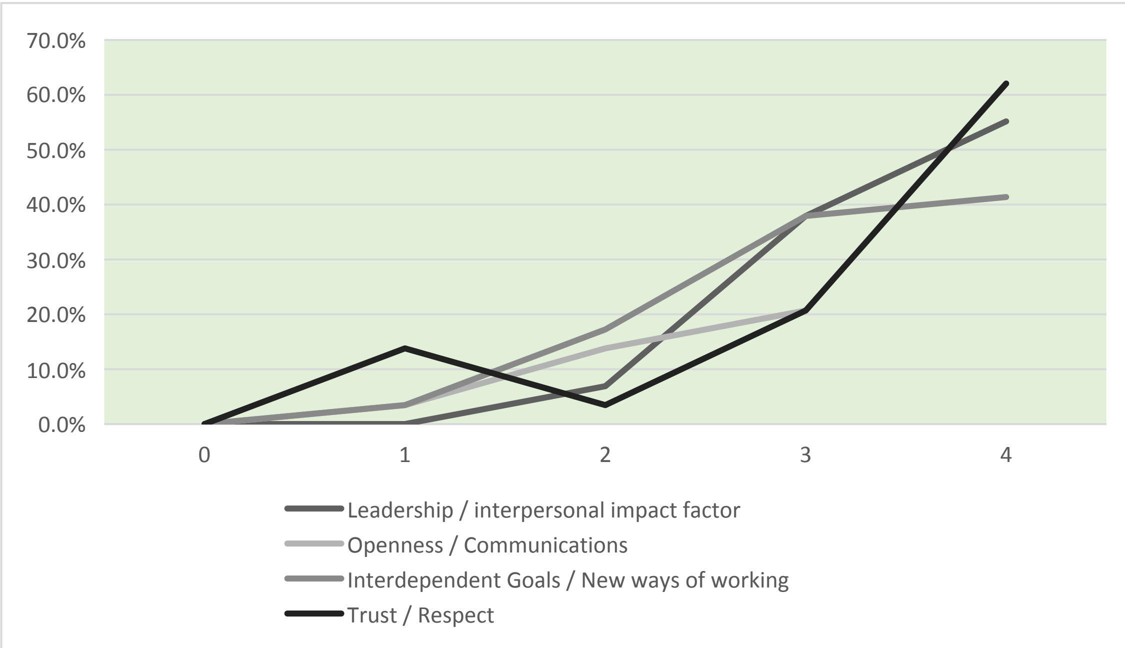


**Figure 8. QS students as project leaders and perceived importance of collaborative behaviours**

| **Maturity Level** | 0 | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| Leadership / interpersonal im | 0.0% | 0.0% | 13.8% | 41.4% | 44.8% | **100.0%** |
| Openness / Communications | 0.0% | 3.4% | 3.4% | 34.5% | 58.6% | **100.0%** |
| Interdependent Goals / New | 0.0% | 3.4% | 6.9% | 31.0% | 58.6% | **100.0%** |
| Trust / Respect | 0.0% | 6.9% | 6.9% | 31.0% | 55.2% | **100.0%** |
| **%** | **0.0%** | **13.8%** | **31.0%** | **137.9%** | **217.2%** | **400.0%** |

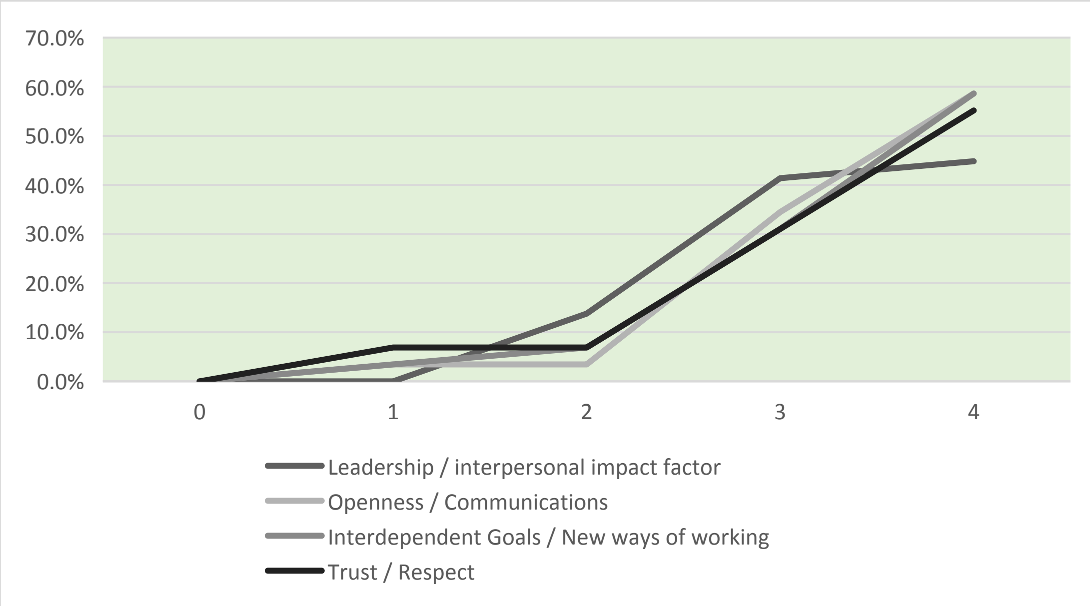





**Figure 9. The Collaborative Behavioural Map**

| Maturity Level | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Project Contributor | 0.0% | 20.7% | 41.4% | 117.2% | 220.7% |
| Project Leader | 0.0% | 13.8% | 31.0% | 137.9% | 217.2% |

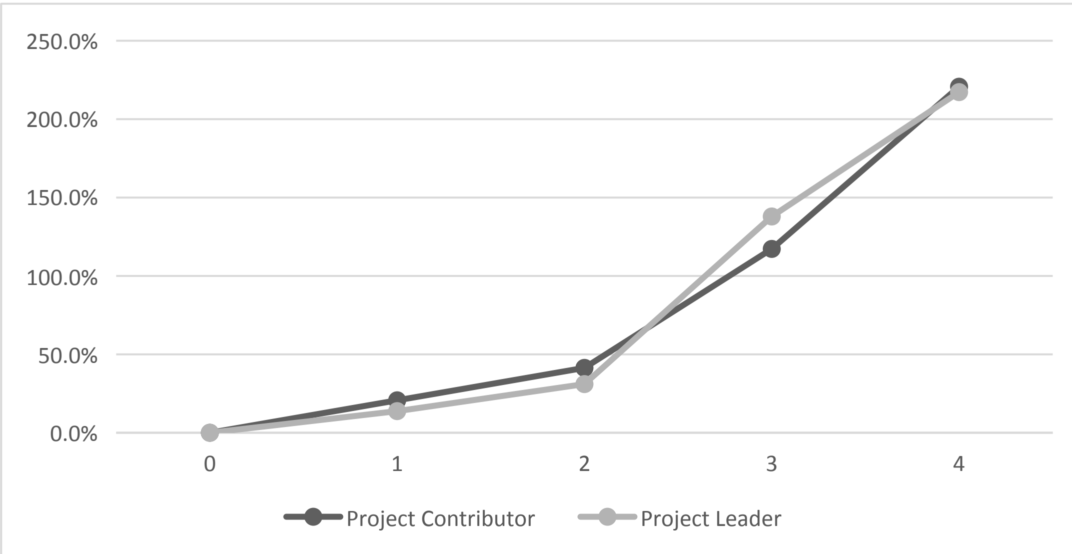


**Table 1.** Collaborative behavioural mapping of QS students at a UK university.

| | Leadership / interpersonal impact factor | | | | | | | | | | Openness / Communications | | | | | | | | | | Interdependent Goals / New ways of working | | | | | | | | | | Trust / Respect | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Project Contributor | | | | | Project Leader | | | | | Project Contributor | | | | | Project Leader | | | | | Project Contributor | | | | | Project Leader | | | | | Project Contributor | | | | | Project Leader | | | | |
| | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 |
| 8E |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  | 1 |  |  |  |  |  |  |  | 1 |
| 10E |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |
| 10F |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |
| 10G |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |
| 10H |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |
| 11E |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  | 1 |  |  |  |  | 1 |  |  |
| 12E |  |  |  |  | 1 |  |  |  | 1 |  |  |  | 1 |  |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  |  | 1 |
| 12F |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  | 1 |  |
| 12G |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |
| 13E |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |
| 13F |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  | 1 |  |
| 13G |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |
| 15E |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  |  | 1 |  |  |  |  | 1 |
| 16F |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |
| 16G |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |
| 17F |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |
| 18E |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |
| 18F |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  | 1 |  |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |
| 20D |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |
| 20E |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  | 1 |  |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |
| 21D |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  | 1 |  |
| 21E |  |  |  |  | 1 |  |  | 1 |  |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |
| 23E |  |  |  | 1 |  |  |  |  | 1 |  |  | 1 |  |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  | 1 |  |  |  |  |  | 1 |  |  |
| 24E |  |  |  | 1 |  |  |  | 1 |  |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |
| 25D |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  | 1 |  |
| 26E |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  | 1 |  |  |  |
| 26F |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |
| 31E |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |
| 31F |  |  |  | 1 |  |  |  |  | 1 |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  | 1 |  |  |  |  |  | 1 |  |  |  | 1 |  |
| | 0 | 0 | 2 | 11 | 16 | 0 | 0 | 4 | 12 | 13 | 0 | 1 | 4 | 6 | 18 | 0 | 1 | 1 | 10 | 17 | 0 | 1 | 5 | 11 | 12 | 0 | 1 | 2 | 9 | 17 | 0 | 4 | 1 | 6 | 18 | 0 | 2 | 2 | 9 | 16 |
| | 0.0% | 0.0% | 6.9% | 37.9% | 55.2% | 0.0% | 0.0% | 13.8% | 41.4% | 44.8% | 0.0% | 3.4% | 13.8% | 20.7% | 62.1% | 0.0% | 3.4% | 3.4% | 34.5% | 58.6% | 0.0% | 3.4% | 17.2% | 37.9% | 41.4% | 0.0% | 3.4% | 6.9% | 31.0% | 58.6% | 0.0% | 13.8% | 3.4% | 20.7% | 62.1% | 0.0% | 6.9% | 6.9% | 31.0% | 55.2% |

Table is also supplied as Excel file in case needed.

| | Leadership / interpersonal impact factor | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Project Contributor | | | | | Project Leader | | | | |
| | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 |
| 8E | | | 1 | | | | | 1 | | |
| 10E | | | | | 1 | | | | | 1 |
| 10F | | | | | 1 | | | | | 1 |
| 10G | | | | | 1 | | | | | 1 |
| 10H | | | | | 1 | | | | | 1 |
| 11E | | | | 1 | | | | | 1 | |
| 12E | | | | | 1 | | | | 1 | |
| 12F | | | | 1 | | | | | 1 | |
| 12G | | | | 1 | | | | | 1 | |
| 13E | | | | 1 | | | | | 1 | |
| 13F | | | | 1 | | | | | 1 | |
| 13G | | | | 1 | | | | | 1 | |
| 15E | | | 1 | | | | | 1 | | |
| 16F | | | | | 1 | | | | | 1 |
| 16G | | | | | 1 | | | | | 1 |
| 17F | | | | | 1 | | | | | 1 |
| 18E | | | | | 1 | | | | | 1 |
| 18F | | | | | 1 | | | | | 1 |
| 20D | | | | | 1 | | | | | 1 |
| 20E | | | | | 1 | | | | | 1 |
| 21D | | | | | 1 | | | | | 1 |
| 21E | | | | | 1 | | | 1 | | |
| 23E | | | | 1 | | | | | 1 | |
| 24E | | | | 1 | | | | 1 | | |
| 25D | | | | | 1 | | | | 1 | |
| 26E | | | | | 1 | | | | | 1 |
| 26F | | | | 1 | | | | | 1 | |
| 31E | | | | 1 | | | | | 1 | |
| 31F | | | | 1 | | | | | 1 | |
| | 0 | 0 | 2 | 11 | 16 | 0 | 0 | 4 | 12 | 13 |
| | 0.0% | 0.0% | 6.9% | 37.9% | 55.2% | 0.0% | 0.0% | 13.8% | 41.4% | 44.8% |

| | Openness / Communications | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Project Contributor | | | | | Project Leader | | | | |
| | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 |
| 8E | | | | 1 | | | 1 | | | |
| 10E | | | | | 1 | | | | | 1 |
| 10F | | | | | 1 | | | | | 1 |
| 10G | | | | | 1 | | | | | 1 |
| 10H | | | | | 1 | | | | | 1 |
| 11E | | | | | 1 | | | | | 1 |
| 12E | | | 1 | | | | | | | 1 |
| 12F | | | | 1 | | | | | 1 | |
| 12G | | | 1 | | | | | | 1 | |
| 13E | | | 1 | | | | | 1 | | |
| 13F | | | | | 1 | | | | | 1 |
| 13G | | | | | 1 | | | | | 1 |
| 15E | | | | 1 | | | | | 1 | |
| 16F | | | | | 1 | | | | | 1 |
| 16G | | | | | 1 | | | | | 1 |
| 17F | | | | | 1 | | | | 1 | |
| 18E | | | | | 1 | | | | | 1 |
| 18F | | | | | 1 | | | | | 1 |
| 20D | | | | | 1 | | | | | 1 |
| 20E | | | | | 1 | | | | | 1 |
| 21D | | | | | 1 | | | | 1 | |
| 21E | | | | | 1 | | | | | 1 |
| 23E | | 1 | | | | | | | 1 | |
| 24E | | | | | 1 | | | | | 1 |
| 25D | | | | | 1 | | | | | 1 |
| 26E | | | | 1 | | | | | 1 | |
| 26F | | | | 1 | | | | | 1 | |
| 31E | | | | 1 | | | | | 1 | |
| 31F | | | 1 | | | | | | 1 | |
| | 0 | 1 | 4 | 6 | 18 | 0 | 1 | 1 | 10 | 17 |
| | 0.0% | 3.4% | 13.8% | 20.7% | 62.1% | 0.0% | 3.4% | 3.4% | 34.5% | 58.6% |

| | Interdependent Goals / New ways of working | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Project Contributor | | | | | Project Leader | | | | |
| | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 |
| 8E | | | 1 | | | | | | 1 | |
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| 10H | | | | | 1 | | | | | 1 |
| 11E | | | | | 1 | | | | | 1 |
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| 31E | | | | 1 | | | | | 1 | |
| 31F | | | | 1 | | | | | 1 | |
| | 0 | 1 | 5 | 11 | 12 | 0 | 1 | 2 | 9 | 17 |
| | 0.0% | 3.4% | 17.2% | 37.9% | 41.4% | 0.0% | 3.4% | 6.9% | 31.0% | 58.6% |

| | Trust / Respect | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Project Contributor | | | | | Project Leader | | | | |
| | 0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 |
| 8E | | 1 | | | | | | | | 1 |
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| 31F | | | | | 1 | | | | 1 | |
| | 0 | 4 | 1 | 6 | 18 | 0 | 2 | 2 | 9 | 16 |
| | 0.0% | 13.8% | 3.4% | 20.7% | 62.1% | 0.0% | 6.9% | 6.9% | 31.0% | 55.2% |

Report **September 2013**

# **RICS** Research

## RICS Professional Competency Mapping Framework for Programme Appraisal and Benchmarking


RICS

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# RICS Professional Competency Mapping Framework for Programme Appraisal and Benchmarking

Report for Royal Institution of Chartered Surveyors

RICS

**A report for Royal Institution of Chartered Surveyors**

Report written by:

Prof. Srinath Perera MRICS
srinath.perera@northumbria.ac.uk
Northumbria University, Newcastle upon Tyne, UK

Mr John Pearson FRICS
john.pearson@northumbria.ac.uk
Northumbria University, Newcastle upon Tyne, UK

Research team:

Dr Lei Zhou and Damilola Ekundayo
Northumbria University, Newcastle upon Tyne, UK

## RICS Research team

Dr. Clare Eriksson FRICS
Director of Global Research & Policy
ceriksson@rics.org

James Rowlands
Global Research & Policy Project Manager
jrowlands@rics.org

Amanprit Johal
Global Research & Policy Project Officer
ajohal@rics.org

Published by:

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United Kingdom

rics.org/research

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## List of Abbreviations

**RICS** Royal Institution of Chartered Surveyors
**QS** Quantity Surveying
**CMF** Competency Mapping Framework
**CMT** Competency Mapping Template
**CMR** Competency Mapping Record
**GCTB** Graduate Competency Threshold Benchmark
**CNAA** Council for National Academic Awards
**HND** Higher National Diploma
**APC** Assessment of Professional Competence
**PQS** Private sector consultant Quantity Surveyor
**CQS** Contractor's Quantity Surveyor

# Foreword

**The research undertaken has relevance for RICS in highlighting the importance of the links between the curricula of accredited courses and the APC competencies (Assessment of Professional Competence). The paper raises a number of pertinent recommendations, and through current developments in relation to RICS accreditation policy, have already been addressed in a proactive and positive way by the RICS. The research was independently carried out through the funding support of the RICS Research Trust and therefore provides an independent, arm's length review of the issues surrounding competency mapping framework in RICS accredited courses.**

It is a requirement of RICS accreditation that all courses must consistently map and align with an appropriate APC pathway. RICS has avoided adopting a prescriptive approach to ensure that there are no barriers to innovation in curricula, and providing universities with the flexibility to adapt to changes in professional practice, such as the evolution of new technology. RICS are currently advancing an approach that would benefit graduates in today's world where transferable skills such as commercial skills are required in addition to complementary technical understanding and knowledge.

The competencies threshold benchmark concept detailed in this report provides RICS with some interesting food for thought and has obvious merits. However in practice it would be challenging to adopt the methodology on a worldwide basis given the diversity of RICS pathways and the need to maintain a consistent global accreditation policy. Other professional bodies tend to represent a single homogeneous profession constituency and do not have to consider trying to develop policy which reflects RICS' professional diversity on a global level. While recognising these challenges for RICS itself, RICS partner universities are welcome to adopt the merits of this methodology when reviewing their accredited provision to meet the current needs of students and employers.

The UK Education Standards Board (UKESB) is developing a new Quality Threshold which will increase the focus on course curricula and its relationship to the APC competencies. It is likely that a minimum threshold will be established for mapping curricula to APC competencies. Universities will also be required to provide mapping documents on a periodic basis in line with major course reviews. In addition guidance can be produced to help universities develop courses which closely align to the competencies. The new Quality Threshold will replace the entry threshold, and the current framework of four thresholds will remain. The UKESB is looking to enhance the quality assurance with a range of more relevant standards.

We are pleased to report that the RICS has now addressed many of the concerns and issues raised in the paper, through changes to the threshold standards to be globally applicable and we will continue to review these standards for our accredited courses worldwide. This allows future professionals to complete their APC successfully through university and the workplace.

**Nick Evans**
RICS UK Higher Education Policy Manager

# Part 1
# Executive Summary

## Background

Over the years QS education has evolved from being rather technical in nature into fully fledged honours degrees with greater orientation towards commercial management, cost, contracts and project management. The current network of Quantity Surveying Degrees grew from the early 1970's with the move from Diploma to Degree level qualification for entry to the profession. This transition from diplomas to university degrees was in cognition with the general transformation of the higher education sector of the British education system. The majority of these degrees were delivered by the former Polytechnics, the most of which, in turn, became New Universities in the early 1990's or thereabouts. With the conversion to University status came their right to validate and award degrees (previously validated by and awarded under the auspices of the Council for National Academic Awards (CNAA), to whom the former Polytechnics were answerable).

*"Up until 1994, the RICS ran its own examinations, but since [then] there has been a progressive change towards qualification through accredited courses at undergraduate and postgraduate level"* **(RICS, 2008a)** This process has recently taken a further turn with the introduction of the Assoc. RICS route.

During this period the construction industry has undergone many changes and is currently facing a double dip economic recession which has a severe impact on opportunities for graduate employment within the sector. Construction industry employers have been vocal in reporting their perception of a lowering of employability of graduates. A recent study investigating views on both industry and academia concluded that there are significant levels of dissatisfaction with the quality of graduates (Perera & Pearson, 2011). It identified the root cause of the issue as graduates produced from different RICS accredited degree programmes having significantly different competency levels, often far below what the industry expects. This research following from the recommendations of the above report, aims at developing a competency mapping framework for programme appraisal and benchmarking.

## Research Method

This research adopted a four stage research strategy to develop the CMF.

The four stages were:

### **Stage 1** – Pilot Study:

A literature review of competencies was carried out which identified the RICS APC study checklist. It used two industry and academic experts to iteratively develop and modify a competency mapping template (CMT). The CMT is a dual vector scale matrix with a Breadth scale and a Depth scale each mapped against module descriptors. Breadth scale contains study topics while Depth scale contains competencies.

### **Stage 2** – Case Studies:

Four leading RICS accredited QS degree programmes were analysed and their module specifications were mapped to competencies using the CMT. This created a CMR for each case study. Descriptive statistical analysis was used to develop a conceptual competency benchmark using these four case studies.

### **Stage 3** – Expert Forum:

An expert forum with 15 experts (12 industry experts and 3 academic experts) was established to revise and modify the conceptual competency benchmark. The two stage Delphi process was used to record and harmonise the views of experts. This stage produced the final graduate competency threshold benchmark (GCTB).

### **Stage 4** – Review of Existing Processes to Integrate CMF:

The final stage of the research involved reviewing existing programme development and validation methods, RICS programme accreditation and RICS – University partnership processes. This involved a document review as well as interviews of three QS degree programme directors to obtain their views on these processes and the proposed incorporation of GCTB within these. The report suggests how the CMF can be used within these existing systems to ensure academic quality standards.

# Competency Mapping Framework (CMF)

## RICS QS Competencies

QS competencies are the most developed and well documented set of competencies produced by the RICS. There are 25 competencies categorised as Mandatory, Core or Optional.

**Mandatory Competencies:** Competencies that are generally required by most surveying professions. These provide a basic skill set that are required for working as a professional in the construction industry. There are 8 competencies in this category.

**Core competencies:** These define the core skill base of the QS and therefore essential for practicing as a QS. There are 7 unique competencies in this category.

**Optional competencies:** these are competencies that are desired in a QS. As such only two competencies are required to be satisfied from this category for completion at APC. However, at graduate level all these competencies become important as providing foundation level of knowledge.

The RICS distinguishes between three possible levels of attainment in each of a range of competences when setting its requirements for those seeking full membership. Briefly, these are as follows:

- **Level 1:** Knowledge (theoretical knowledge)
- **Level 2:** Knowledge and practical experience (putting it into practice)
- **Level 3:** Knowledge, practical experience and capacity to advise (explaining and advising)

Although there are clear guidelines for achieving competencies at APC, there is no stipulation as to the level of achievement of competencies at graduate level. In the absence of such a benchmark different universities achieve these competencies at different levels (Perera & Pearson, 2011) resulting in greater variation in level of quality of graduates.

## Competency Mapping Scoring System

A dual vector scale scoring matrix was developed to map programme curricula to RICS competencies. The scoring system is presented in a competency mapping template (CMT) on a MS Excel™ spreadsheet. It contains two tabs one each for the Breadth scale and Depth scale. The Breadth scale lists all study check list topics categorised to competencies vertically downwards with list of programme modules on the horizontal axis. The Depth scale consists of a matrix containing competencies on the vertical axis against programme modules on the horizontal axis.

Scoring on the Breadth scale tab is to indicate a mapping of which topics area dealt by which module with a mark-up of 1 or 0 to indicate topic covered and not covered scenarios respectively. The Breadth scale matrix is completed indicating achievement of a topic whether at Level 1 or 1 and 2. Scoring on the Depth scale tab is to indicate time spent on learning each topic summed to give total learning hours for each competency. Once CMT is completed for a degree programme, it is known as the CMR for that programme.

## Development Process of the GCTB

The pilot study was used to develop the CMT and the scoring system described in the previous section. With the use of four case studies of the RICS accredited QS degree programmes a CMR was produced for each programme. These were used as the basis for the development of a conceptual benchmark.

The expert forum appointed was requested to review the conceptual benchmark established. Their judgements were collated to produce a revised benchmark. The expert forum was then requested to further modify or agree with the revised benchmark. Following Delphi methodology for harmonising the views of experts a verified benchmark was created. This was then further organised to produce the final GCTB.

**Figure 1.1** Sample image of the Graduate Competency Threshold Benchmark (GCTB)

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C1.8.7 | Supply chain management | 1 | 1 | | | | |
| C1.8.8 | Legislation on selecting project teams | 1 | 0 | | | | |
| C2 | CORE COMPETENCIES | 136 | 43 | 94.4% | 29.9% | 2060 | 65% |
| C2.1 | Commercial management of construction (T010) – Level 3 | 9 | 5 | 100.0% | 55.6% | 96 | 3.0% |
| C2.1.1 | Estimating | 1 | 1 | | | | |
| C2.1.2 | Establishing budgets | 1 | 1 | | | | |
| C2.1.3 | Cash flows | 1 | 1 | | | | |
| C2.1.4 | Reporting financial progress against budget | 1 | 1 | | | | |
| C2.1.5 | Procurement of labour | 1 | 0 | | | | |
| C2.1.6 | Procurement of plant and materials | 1 | 0 | | | | |
| C2.1.7 | Procurement of sub-contracts | 1 | 1 | | | | |
| C2.1.8 | Financial management of supply chain | 1 | 0 | | | | |
| C2.1.9 | Financial management of multiple projects | 1 | 0 | | | | |
| C2.2 | Contract practice (T017) – Level 3 | 28 | 12 | 100.0% | 42.9% | 243 | 7.6% |
| C2.2.1 | Principles of contract law | 1 | 0 | | | | |
| C2.2.2 | Legislation | 1 | 0 | | | | |
| C2.2.3 | Current case-law – look out for cases reported in journals | 1 | 0 | | | | |

## Analysis of the GCTB

The GCTB is the central construct in the CMF. The CMF consists of the competency mapping scoring system, CMT, CMR and the process of incorporating it in the RICS – University partnership.

A sample of the GCTB is presented in Figure 1.1.

The first column in GCTB presents a unique code allocated to each study topic in the GCTB. The study topics for the GCTB are derived from the RICS APC study checklist (RICS, 2008a). The Breadth scale consists of 4 columns. Level 1 and 2 columns indicate the level at which a topic is to be achieved at undergraduate level. The other two columns present statistics of percentage coverage of topics at Levels 1 and 2 respectively. The Depth scale consists of two columns. The Credit hours column indicates the amount of time an undergraduate student should spend in learning topics related to a competency. The final column provides statistics of the percentage time allocation for a competency. The header row of the GCTB presents summary statistics applicable for the respective columns.

The summary statistics of the GCTB is presented in Table 1.1.

**Table 1.1** **Summary statistics of GCTB**

| | | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| Competency Type | | Level 1 Topics | Level 2 Topics | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| C1 | Mandatory Competencies | 66 | 31 | 88% | 41% | 521 | 16% |
| C2 | Core Competencies | 136 | 43 | 94% | 30% | 2060 | 65% |
| C3 | Optional Competencies | 103 | 28 | 74% | 20% | 607 | 19% |
| Totals | | 305 | 102 | 85% | 28% | 3188 | 100.0% |

Analysing the Breadth scale it is clear that there are a total of 305 topics to be covered representing 85% of total topics at Level 1. As one would expect, this comes down to 102 topics (28%) at Level 2. Core competencies have 94% coverage of topics at Level 1. However, the highest coverage at Level 2 is for Mandatory competencies (41%). This is mainly because those Mandatory competencies represent generic skills and as such are expected to be covered to a higher degree of competence at graduate level.

Analysing the Depth scale, there are a total of 3188 hours of learning time expected on RICS competencies. This is out of possible 3600 hours representing 89% of time. In comparison to average values of the case studies this represents a 4% increase from 85% RICS competency mapped time. This is much higher than current provision of most RICS accredited programmes. As expected, 65% of the time is expected to be spent on Core competencies which accounts for 57% full credit allocation for a degree programme. There is 3% increase from the case studies. However, this represents a reasonable content considering the specialist nature of the profession. This is then followed by Optional and Mandatory competencies.

Another notable change from the existing provision is the consequent reduction in time allocation with respect to learning related to Non RICS competencies. There is a 3% reduction in time. These learning primarily represent generic study areas such as basic economics, law, mathematical skills etc. However, one could argue as these underpin direct RICS competency related topics. It is for this reason that future revisions to competencies and the study checklist should consider the inclusion of such topics at Level 1.

The amount of time to be spent on any one topic is difficult to precisely stipulate. If prescribed, it will become too prescriptive creating a barrier for innovation in curricula. The uniqueness of individual degree programmes will therefore be defined on the lines of variations in the extent and level of coverage of topics. The GCTB facilitates adequate provision for innovation in individual degree programmes while ensuring minimum levels of satisfaction of competencies.

**Table 1.2** **Comparison of proposed competency time allocations (GCTB)**

| | | Proposed on GCTB | | Existing Composition (Case Studies) | |
|---|---|---|---|---|---|
| Competency Type | | Credit hours | % Percentage | Credit hours | % Percentage |
| C1 | Mandatory Competencies | 521 | 15% | 557 | 16% |
| C2 | Core Competencies | 2060 | 57% | 1899 | 53% |
| C3 | Optional Competencies | 607 | 17% | 628 | 17% |
| C4 | Non RICS Competencies | 412 | 11% | 517 | 14% |
| Totals | | 3600 | 100% | 3600 | 100% |

## Incorporating and using CMF

This research examined the current programme development and validation processes used in the university systems. It also reviewed the RICS programme accreditation process and the RICS – University partnership process through a series of interviews with three well experienced academics with programme management responsibilities. It is clear that CMF presents a useful methodology to map programme curricula to RICS competencies. It also provides a tool for management of programme developments.

When new programmes are developed, the GCTB can be used to identify module content for module descriptors. It is suggested that the CMT to be used to initially map topics within module descriptors (specifications) to RICS competencies. The systematic approach presented in the CMF helps in this process to ensure that competency levels exceed minimum requirements. Upon completion of the CMT the resultant CMR forms an authentic record of how module descriptors are mapped to RICS competencies. These can then be made part of programme validation and programme accreditation documents.

The GCTB can be used to evaluate existing RICS accredited degree programmes. When a CMR for a RICS accredited degree programme is created, it forms a formal record of how degree programme content maps to RICS competencies. This can then be evaluated against the GCTB to identify whether degree programmes fully comply with the minimum thresholds identified in the GCTB. Where benchmarks are not achieved programmes can be modified to comply with GCTB. In a similar way the CMR for the programme should be updated whenever programme modifications or module modifications are carried out. It can then be checked against the GCTB to check compliance. It is proposed that the CMR be made an essential document in the RICS – University partnership process ensuring exit quality of graduates.

The main thrust of the current research seeks usefully to improve the relationship between that which is taught in our academic institutions and that which is sought by the industry, to better meet and satisfy their own demands and those of industry. However, the report recognises that some "related study skills" not currently recognised by RICS competencies may be necessary precursors, and that some time must be allowed for the delivery and assessment of these. Equally, there are certain generic "transferable" skills which it is the duty of the academic to instil, and time must be allocated to this process also.

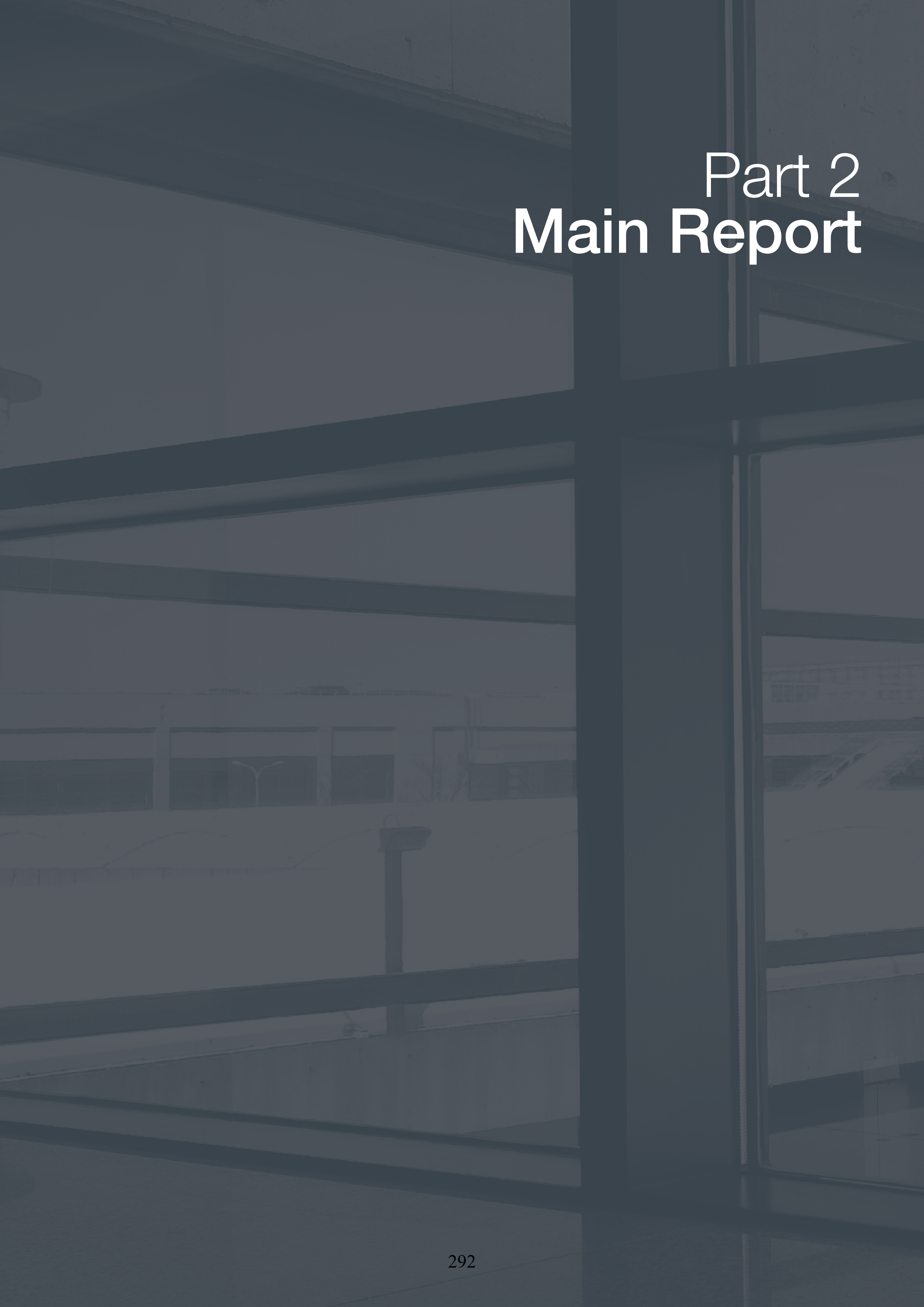
## Conclusions and Recommendations

The current research aimed to develop a competency mapping framework for programme appraisal and benchmarking. This report presents this as a competency mapping framework (CMF) consisting of three essential instruments viz. GCTB, CMT and CMR. In achieving the CMF a logical learning credit based competency mapping scoring system has been developed integrating it to the instruments stated before.

This report introduces CMF as a system for maintaining and improving quality and professional standards of QS degree programmes accredited by the RICS. The following are the primary recommendations of the report.

- It is recommended that the CMF be made an essential part of the RICS – University partnership agreement. This way it provides a mechanism to ensure that all RICS accredited programmes meet the exit threshold defined by the GCTB. Each RICS accredited programme should complete a CMR which then can be updated and presented to the RICS – University partnership meeting annually with any changes made being highlighted.
- CMF should be used for ensuring achievement of competencies in all new QS degree programmes to be accredited by the RICS. It should form part of programme validation and accreditation documents (where RICS accreditation is sought).
- In the case of all new programmes seeking RICS accreditation, completion of the CMR should be mandatory, to ensure it meets GCTB thresholds.
- The CMF also provides a useful process for the programme external examiners. They can be entrusted to comment on the changes to programmes evaluated against the GCTB thereby ensuring compliance.
- The GCTB recommends only 84% of study topic-related competencies at Level 1. It is suggested that innovative programmes should aim at achieving the remaining over and above the minimum benchmark recommended.

The GCTB developed and presented herein is based on current RICS competencies (RICS, 2009) and APC study Checklist documentation (RICS, 2008a). It is recommended that whenever competency structures change the GCTB should be updated accordingly.



# Part 2
# **Main Report**

## 1.1 Background

Research previously carried out into aligning Professional, Academic and Industrial Development Needs of Quantity Surveyors (Perera and Pearson, 2011) indicated that there are significant disparities between Industry and Academic quantity surveyors in their interpretation of RICS competencies. The industry professionals had very high expectations of the graduate quantity surveyors while the academics thought they fulfilled these requirements.

The RICS (2009a) have clearly defined the level of achievement of competencies required of the Chartered Surveyor. However there is no such definition for the level of achievement of competencies for the graduate quantity surveyor. This has resulted in individuals and organisations interpreting levels of achievement of competencies each in their own way.

The situation can be represented graphically below (Figure 2.1).

The maroon solid line indicates the level of achievement of competencies for attainment of Chartered status as defined by RICS (2009). The Green, Red and Blue broken lines indicate the achievement of competencies by graduates as interpreted by different universities and industry professionals for Mandatory, Core and Optional competencies. These interpretations are all for RICS accredited quantity surveying honours degree programmes across the UK. The lack of a common benchmark for the interpretation of achievement of competencies by graduates therefore, clearly might contribute to the dissatisfaction and false expectations.

The significance of the expectations of the RICS and any value placed upon components of the degrees awarded by differing academic institutions is dependent upon the definitions associated with each of the levels of attainment.

These are as follows;

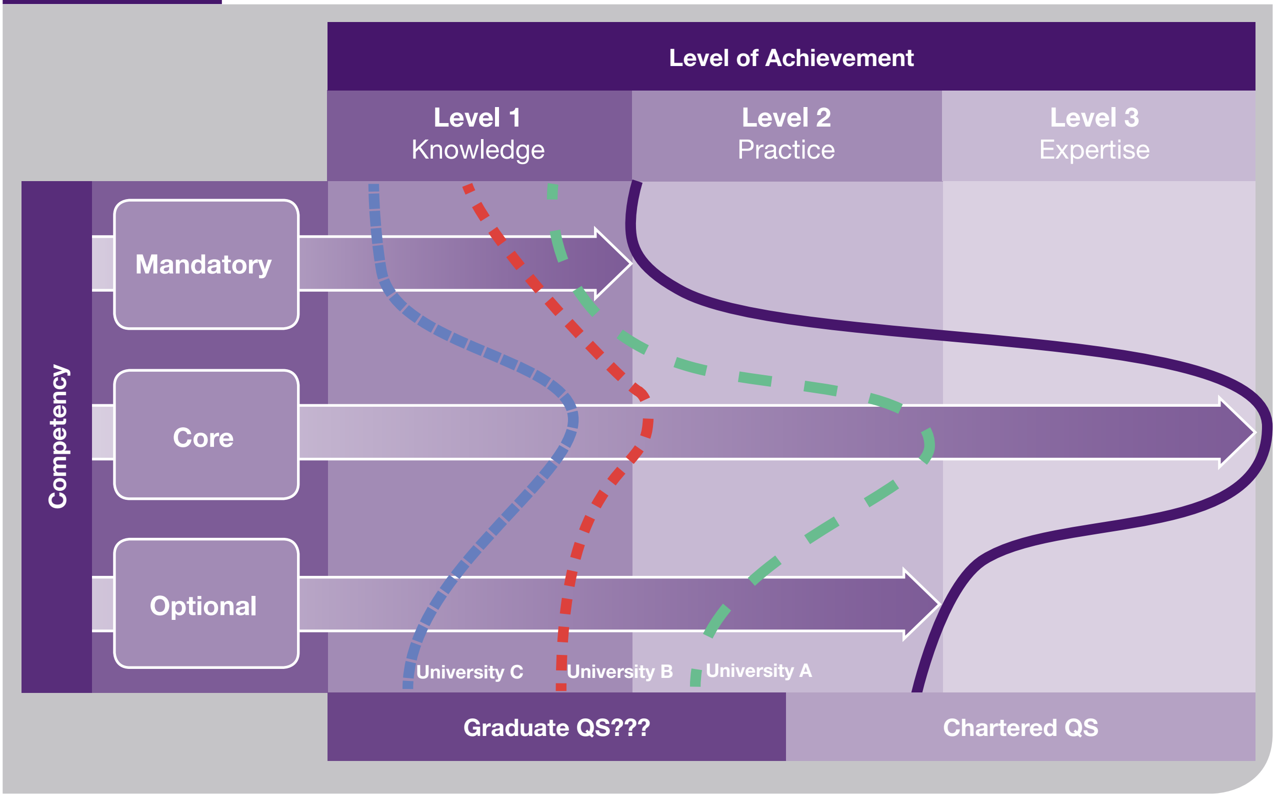
**Level 1:** Knowledge and understanding

**Level 2:** Application of knowledge and understanding

**Level 3:** Reasoned advice and depth of technical knowledge

It will be noted that the RICS generally seeks Level 3 only in the area of Core Competences. Competency at Level 3 can only be achieved after considerable working experience in the industry. It is unlikely that newly qualified graduates will have attained Level 3, with its suggestion of the offering of reasoned client advice, unless they have followed a five year Part Time mode of study, with constant exposure to the work place throughout this time. However, it is clear that different universities conducting RICS accredited programmes proclaim that they achieve Level 3 in some competencies for all students.

**Figure 2.1** Competency Benchmark Interpretation




**Source:** Perera and Pearson, 2011

Detailed analysis of RICS accredited programme curricula of different universities also exposed that there are significant gaps in competency mapping across different programmes. No such exercise can be deemed reliable and consistent unless there is a fairly precise scoring system or "template" against which to assess the extent of mapping of their curricula. Such a system must achieve two things: a precise accountable interpretation (a recognisable link between the curricula and the competencies) and a precise accountable value (a "score" which demonstrates the "Level" of competence achieved). The lack of a mechanism to systematically evaluate programme module content against RICS competencies and a benchmark for graduate competencies is therefore considered as the core cause of this problem.

Programme approval and validation of new or significantly changed programmes are carried out by the universities according to HEFCE (2010) guidelines. Each module on a new or revised programme will be scrutinised with regards to its learning outcomes, delivery etc. Most professionally oriented programmes sought approval of respective accrediting bodies, in this case the RICS, usually by reference to the External Examiners and validation panel members who will act on behalf of the RICS. The Education Committee of the RICS accredit programmes upon review of documentation for the programmes. In the absence of a systematic process to evaluate the extent of competency mapping it risks being carried out based only on subjective judgement and cursory inspection.

In the UK, the RICS-University partnership agreement is the main mechanism to ensure the academic quality of accredited programmes. This process involves ensuring that certain minimum standards, known as "thresholds" as set out in the guidance and policy document on University partnerships (RICS 2008b), are achieved. It governs the entry criteria for programmes, teaching quality and the attainment of the research and innovation threshold. A stipulation regarding relevant employment of graduates has been waived of late, due to the current economic situation (RICS, 2008b).

At present, there is no formal obligation for programme teams to map their curricula against specific RICS Competencies at specific Levels, although most will seek this outcome to some extent. The guidance and policy document (RICS, 2008b, p.26) does list and refer to the APC requirements, suggesting the "likelihood of meeting threshold standards and leading to an existing APC pathway" as a factor in the accreditation or otherwise of a programme.

The 2010 "vision for high quality education" was set out by an Education Task Force in 1999 (RICS, 2008b). This envisaged strong partnerships between the RICS and a limited number of recognised centres of academic excellence, characterised by not only "an appropriate range of curricula at undergraduate and postgraduate levels", but also "increased freedom for selected universities to develop courses and methods of delivery" at all academic levels. This is a far from prescriptive recipe, which lacks consideration of matching specific levels to core competencies.

## 1.2 Aim & Objectives

These problems and drawbacks are the root cause of dissatisfaction with the quality of graduates expressed by industry professionals. This research aims to develop a RICS professional Competency Mapping Framework (CMF) for analysing the compliance of quantity surveying programme curricula with RICS QS competencies. Achieving this core aim is fundamental to success in aligning the views of industry, academia and the RICS.

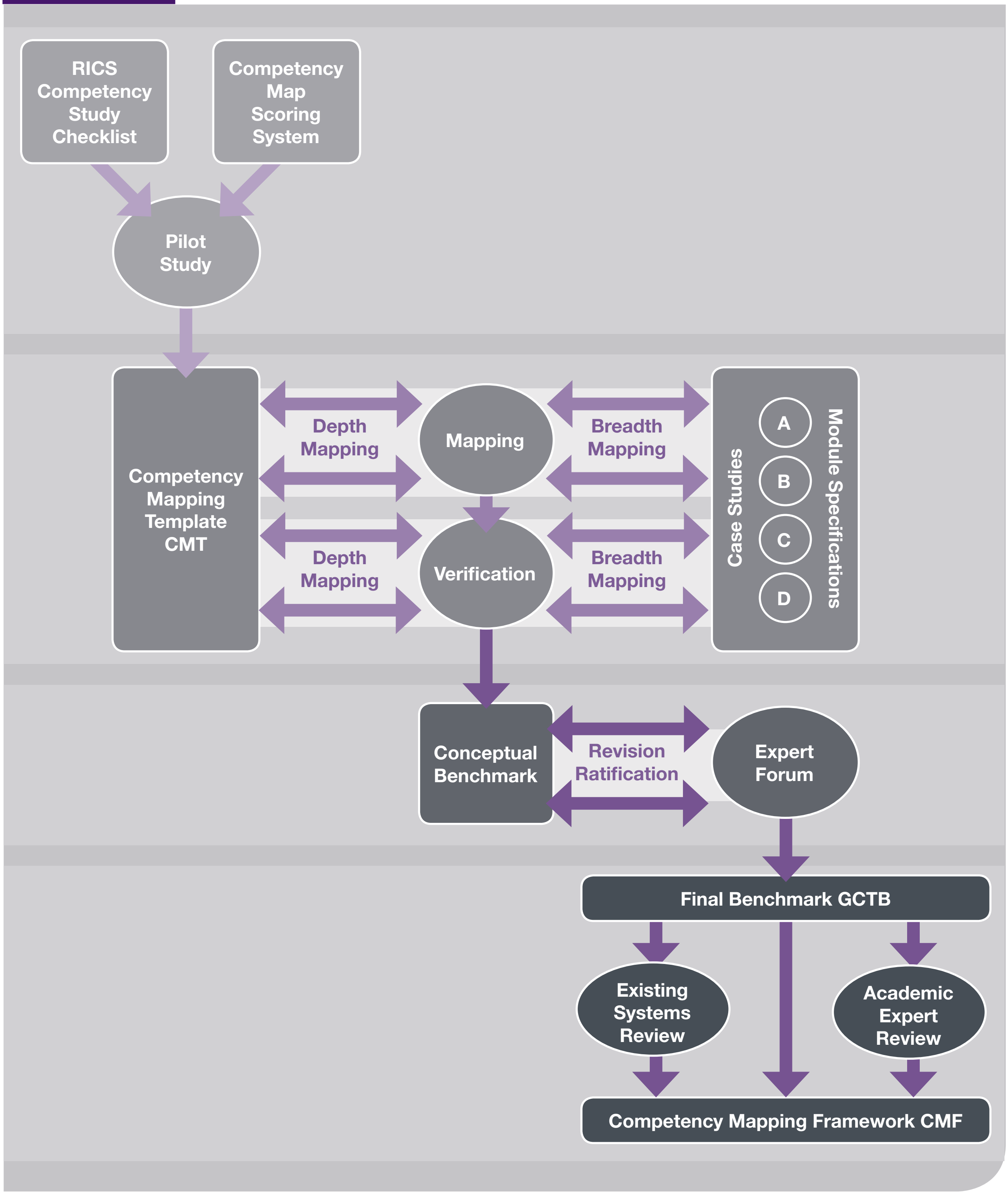
The core aim of the research is further analysed into a set of objectives as follows:

- Examination of the mandatory, core and optional competencies and benchmarking the expected level of compliance for RICS accredited degree programmes.
- Development of a competency mapping and assessment methodology to analyse compliance of programmes to set benchmarks for Graduate route.
- Development of a competency mapping scoring system to analyse the level of mapping and gaps.
- Analysis of the current university programme approval and validation methods and the proposal of a methodology to incorporate a new competency mapping framework for programme approval and validation.
- Analysis of the RICS programme accreditation process to incorporate the competency mapping framework within programme accreditation.
- Analysis of and review of the RICS-University partnership agreement process and propose further developments to it incorporating the Competency Mapping Framework (CMF).

This report presents a detailed account of how these objectives were met and of the development and use of the CMF.

This research uses four distinct data gathering phases, which culminated in data analysis and reporting, to benchmark the expected level of achievement of competencies by the quantity surveying graduates produced by RICS accredited programmes. The final outcome is the Competency Mapping Framework (CMF). The key stages and process are illustrated in Figure 2.2 and further explained below.

**Figure 2.2** Research Method



The following section provides details of the four stages, and the main research instruments used to achieve the research objectives and to develop the graduate competency threshold benchmark (GCTB) and the competency mapping framework (CMF).

## 2.1 Stage 1: Pilot Study

A literature review was conducted to identify the full QS Study checklist structured by RICS QS competencies. This review was in addition to the results of the previous study (Perera and Pearson, 2011) which sets the framework for this research. This was followed by developing a competency mapping scoring system that could provide a numerical scale mapping of competencies to degree programme curricular (refer section 3.2). A pilot study (refer section 3.5.1) involving two academic and industry experts were used to test the scoring system and develop the final Competency Mapping Template (refer section 3.2.3). This template forms the basis for the carrying out of case studies mapping competencies to existing degree programmes.

## 2.2 Stage 2: Case Studies

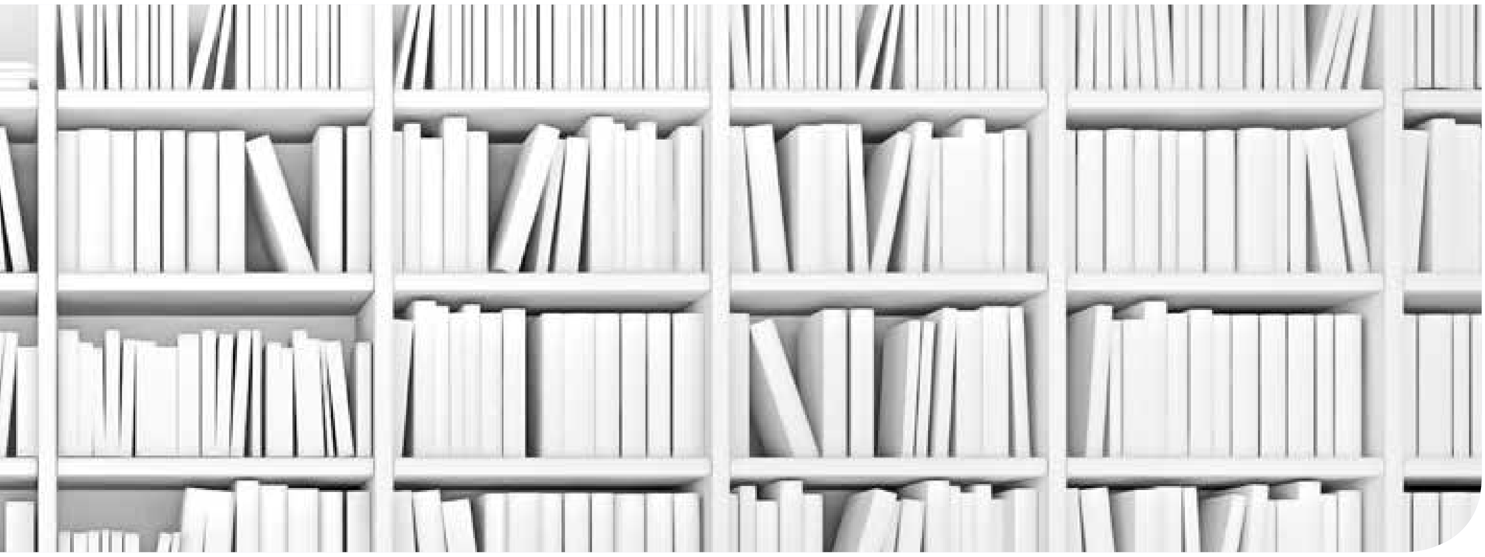
The case studies (A, B, C, and D) provide the basis for the development of the benchmark for graduate competencies. These include examination of four RICS accredited QS degree programmes. The CMT developed in stage 1 provides the template to map curricular to RICS competencies. The curricular of these programmes (module specifications) were mapped against RICS QS competencies at detailed level using coverage (as a breadth scale – section 3.2.1) and amount of time spent in learning i.e. module credits (as a depth scale – section 3.2.2). The ensuing mapping was then verified for accuracy and consistency with programme directors responsible for their delivery. The mapping method and process are further detailed in section 3.3. The output of this stage is the Conceptual Benchmark (refer section 3.4) based on the analysis of the four case studies.

The four case studies selected were leading QS honours degree programmes in the UK all accredited by the RICS. The dual vector scale representing breadth and depth of coverage of competencies informs the current practice in academia. The mapping matrix CMT is an excel spreadsheet with two worksheets or tabs. The breadth mapping worksheet has over 400 rows as it contains the full QS Study checklist whilst the depth mapping worksheet has circa 40 rows since it only includes the RICS QS competencies. The two dimensional matrix thus comprised of QS Study checklist (for breadth mapping tab) and RICS QS competencies (for depth mapping tab) on the Y – axis (vertical listing) and Programme specifications on the X – axis for both tabs (horizontal listing). The rationale for breadth mapping at Study checklist level and depth mapping at competency level is explained in section 3.2.

Both breadth and depth vector scale mappings of the four case studies were initially carried out using the respective module specifications of the programmes. The results were then sent out to the programme leaders concerned for necessary adjustments and ratifications. Descriptive statistics such as mean and percentage scores etc. were used to analyse the results of the four case studies as conceptual benchmark. This forms the basis for the Stage 3 of the research.

## 2.3 Stage 3: Expert Forum

An expert forum comprising 15 industry and academic experts were formed with the objective of revising and refining the conceptual benchmark established in the Stage 2 of the research. The identified industry experts come from large, SME and micro level organisations.



These include quantity surveying employer organisations from both traditional consulting and contracting sectors. A total of 15 interviews were thus carried out comprising 3 academics (programme leaders), 6 consultant quantity surveyors (2 experts from each category of large, SME and micro) and 6 contractor quantity surveyors (2 experts from large, 3 from SME and 1 from Micro level organisation).

This forum was used to benchmark, through an iterative process, the expected level of achievement of competencies by the quantity surveying graduates produced by RICS accredited programmes. Initially, interviews were conducted with each expert using the conceptual benchmark. These interviews were conducted either face to face or using electronic communication with detailed guidance provided in each case. The views of the experts on the conceptual benchmark were sought. The interviews thus involved the experts revising the conceptual benchmark to reflect their expectations of a graduate level attainment of RCIS QS competencies. Analysis of these diverse views resulted in the development of a revised benchmark which has similar layout as the conceptual benchmark.

The final phase of the development process involved using the same identified experts to evaluate the revised benchmark in order to adjust and ratify the revised benchmark values. The revised benchmark was sent via email to the experts with detailed guidance of what is expected. A reminder email was sent accordingly at the end of the first week with a follow-up email in the subsequent week. With circa 80% response rate, around 70% of the experts who replied said they agree and are satisfied with the revised benchmark in which case they returned the revised benchmark with no correction. The remaining 30% of the experts have some minor corrections to make. In this case, they adjusted the revised benchmark values in a similar manner to the initial process. The experts were also asked to provide any further feedback they might have.

The resulting findings were analysed using relevant descriptive statistics and presented as a ratified benchmark. Delphi technique (Rowe and Wright, 2001) was used to extract and harmonise the views of the experts and to finalise the benchmark level of achievement of competencies for graduate quantity surveyors. The ratified benchmark was fine-tuned, adjusted and finalised to produce the minimum graduate competency threshold benchmark (GCTB).

## 2.4 Stage 4: Review of Existing Processes to Integrate CMF

The GCTB forms the basis of the final stage of the research, where it is incorporated in to existing programme curricular development and management process creating the Competency Mapping Framework. A detailed review of the existing programme validation and management methods were carried out. Three well experienced RICS accredited QS honours degree programme directors (who are also full members of the RICS) were selected to develop the mechanism to integrate the GCTB to create the final CMF.

Interviews evaluated the programme approval and validation methods, programme accreditation process and RICS-University partnership agreement process, and how to further improve these processes through the incorporation of the GCTB developed in stage 3. These interview stages are further detailed in section 5. The content analysis of the interviews conducted was the catalyst for the identification of key issues related to the above processes. Accordingly a system to incorporate the developed graduate threshold competency benchmark as a fundamental part of the RICS-University partnership agreements was proposed. This is the CMF.

## 3.1 RICS QS Competencies

The RICS QS Competencies provide the basis on which the competence of a chartered quantity surveyor is defined. These are arranged into three groupings, depending upon their perceived relevance to the role of the quantity surveyor:

**1** – Mandatory Competencies: personal, interpersonal and professional practice and business skills common to all pathways [into membership] compulsory for all candidates.

**2** – Core Competencies: primary skills of the candidate's chosen [RICS] pathway

**3** – Optional Competencies: selected as an additional skill requirement for the candidate's chosen [RICS] pathway from a list of competencies relevant to that pathway. In most cases there is an element of choice, though driven, usually, by their employer's specialism.

The RICS distinguishes between three possible levels of attainment in each of a range of competences when setting its requirements for those seeking full membership. Briefly, these are as follows:

- **Level 1:** Knowledge (theoretical knowledge)
- **Level 2:** Knowledge and practical experience (putting it into practice)
- **Level 3:** Knowledge, practical experience and capacity to advise (explaining and advising)

There are 8 Mandatory competencies, 7 Core competencies and 10 Optional competencies. The RICS stipulates that an APC candidate needs to achieve all Mandatory competencies at Level 2 or above, all Core competencies at Level 3 (except the one not relevant to their specialisation, consulting or contracting, which must be at Level 2. The further requirement is for two Optional competencies at Level 2 or above.

There is no stipulation as to the level of achievement of competencies at graduate level. In the absence of such a benchmark different universities achieve these competencies at different levels (Perera & Pearson, 2010). The following sections discuss the development of a graduate level benchmark for RICS QS competencies.

## 3.2 Competency Mapping Scoring System

The competency mapping scoring system is developed as a dual scale matrix consisting of a Breadth scale and a Depth scale. The Breadth scale indicates the extent of coverage of competencies as mapped to RICS QS Study Checklist (RICS, 2008). The check list provides 359 individual study topics categorised in to 25 different competencies. These signify the extent of coverage (breadth of knowledge) expected under the current set of competencies. The Depth scale provides an indication of the time spent on achieving competencies. These are explored in detail in the following sub sections.

### 3.2.1 Breadth Scale

RICS QS competencies were analysed at a detailed level using the QS Study Checklist (RICS, 2008a). This checklist is used as the framework for developing the conceptual benchmark where the binary alternatives 1 and 0 are used to indicate coverage of a topic under a competency.

**1** – Reflects that the topic is dealt with by the degree programme concerned.

**0** – Reflects that it is not dealt with by the degree programme concerned.

These are indicated against the three level classification of level of achievement by the RICS (RICS, 2009). These are as follows:

- **Level 1:** Knowledge and understanding
- **Level 2:** Application of knowledge and understanding
- **Level 3:** Reasoned advice and depth of technical knowledge

A specific topic may be covered at both Levels 1 and 2. In this case, there is a value 1 in both Level 1 and Level 2 columns. If a topic achieves Level 2 coverage then we assume there is always Level 1 coverage as well. In another topic, if the topic is dealt with at Level 1 only then values 1 and 0 were placed against columns Level 1 and Level 2 respectively. Level 3 achievements are not expected to be covered in degree programmes as it is not practical to expect a graduate to cover a competency at Level 3. However, as the benchmark reflects a minimum conceptual achievement level, it will not prevent anyone achieving a competency at Level 3 if it is feasible within their degree programme.

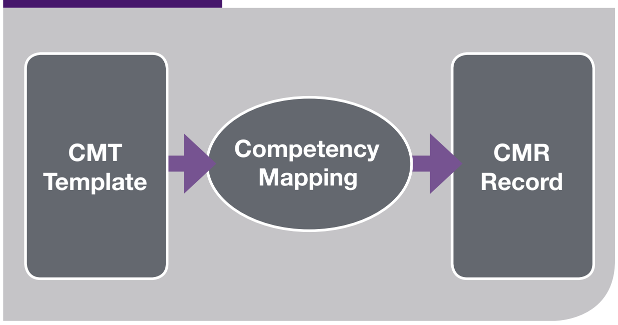
### 3.2.2 Depth scale

This reflects the amount of time spent on achieving a competency. In degree programmes, time spent on achieving module outcome is stipulated as Credits where 10 hours spent is considered as 1 Credit. A typical 20 Credit point module reflects 200 hours of learning by the student. This constitutes direct contact with formal teaching; lectures, seminars, tutorials and such direct contact time as well as students expected study time on the module content (time spent by students on their own in learning a topic concerned). The depth scale is only indicated at competency level and not at topic level as it is impractical to stipulate an expected number of study hours at a detailed level. Percentage scores are used to indicate the amount of time spent on each competency. These provide valuable information on relative time spent for each competency. The Depth scale represents the time expected to be spent on learning a competency at undergraduate level.

## 3.2.3 Competency Mapping Template (CMT) and Competency Mapping Record (CMR)

A Competency Mapping Template (CMT) incorporating the Breadth and Depth scales was developed on a spread sheet using the competency mapping scoring system described above (Refer Appendix B & C). It contains two tabs, one each for the Breadth scale (mapping) and the Depth scale (mapping). The Breadth mapping tab contains the study checklist topics organised into competencies (vertical) mapped against module specifications (horizontal). In a similar way the Depth mapping tab contains the RICS QS competency list (vertical) mapped against module specifications (horizontal).

**Figure 2.3** Competency Mapping Process




The mapping process involves taking each module specification, identifying module topics and mapping them against the Breadth scale. Subsequently, time utilised for each topic for a competency is estimated and noted in the corresponding cell in the Depth scale mapping tab. When all Breadth and Depth scale information is recorded for a degree programme it becomes a record of how module content is mapped against RICS competencies. This is termed as the Competency Mapping Record (CMR) for the programme.

## 3.3 Competency Mapping Case Studies

### 3.3.1 Developing the Conceptual Benchmark

The conceptual benchmark was developed by mapping module specifications of four RICS accredited QS honours degree programmes to the RICS Study Checklist (RICS, 2008a) using the CMT described in section 3.2.3. The four degree programmes are considered as four case studies. The process used in mapping competencies for the case studies is summarised below:

1. Invitation for case study of the selected QS degree programme was sent to the respective programme director explaining the process.
2. The module specifications and the programme module structure were obtained from the respective case study (university).
3. The Competency Mapping Template (CMT) with the Breadth and Depth scales is used to map the RICS QS competencies to the module specifications.
4. Programme module specifications are individually mapped to competencies using the CMT by the research team.
    - **a.** Topics for each module were identified and mapped to those in the Breadth scale of study checklist topics.
    - **b.** Using the module credit allocation and proportionately distributing it to module content, the learning time allocation for each topic was estimated and allocated in the Depth scale.
    - **c.** The process continued iteratively until mapping of all modules was completed to researchers' satisfaction.
    - **d.** The completed mapping for a degree programme is termed a competency mapping record (CMR).
5. The completed competency mappings (CMRs) were then sent to the respective programme directors for further revision.
6. Revisions were discussed and agreed with the programme directors to finalise the competency mapping record (CMR) of each programme.

Each RICS competency is made up of several topics (known as the study checklist). The breadth mapping, which is the scope of coverage, was carried out across Level 1 and Level 2. Level 3 is not included because a QS graduate would not have attained this level upon graduation. Since the benchmark is a minimum threshold it is not required to be considered. The depth mapping was carried out at competency level, unlike the breadth mapping which was carried out at detailed study checklist level. Credits hours are used for the depth mapping. There are a total of 360 Credits (3600 hours) of learning in a degree programme. Therefore typically there will be less than 3600 hours available to map against RICS competencies. This is because a typical degree programme contains topics that related to but not specifically identified within RICS competencies. For example, subject areas of basic economics, mathematics, or topics such as the background to the legal system are not directly related to RICS competencies.

Both breadth and depth mappings of the above case studies were initially carried out by the researchers using the respective programme specifications. The results were then sent out to the programme leaders of the degree programmes concerned for necessary adjustments and ratifications. Descriptive statistics such as mean and percentage scores were used to analyse and present the results of the case studies as conceptual framework.

**Table 2.1** Comparative analysis of competency mapping case studies

| Code | University: | A | B | C | D | Average | Percentage | Standard Deviation |
|---|---|---|---|---|---|---|---|---|
| | Level: | | | | | | | |
| | Credits: | 340 | 330 | 460 | 450 | | | |
| | Hours | 3400 | 3300 | 4600 | 4500 | | | |
| Code | Competency | | | | | | | |
| | **Mandatory Competencies** | | | | | | | |
| M001 | Accounting principles and procedures | 5 | 0 | 5 | 5 | 3.75 | 0.1% | 2.50 |
| M002 | Business planning | 30 | 10 | 5 | 55 | 25 | 0.8% | 22.73 |
| M003 | Client care | 25 | 5 | 60 | 40 | 32.5 | 1.1% | 23.27 |
| M004 | Communication and negotiation | 89 | 165 | 185 | 155 | 148.5 | 4.8% | 41.58 |
| M005 | Conduct rules, ethics and professional practice | 20 | 30 | 55 | 10 | 28.75 | 0.9% | 19.31 |
| M007 | Data management | 85 | 65 | 90 | 120 | 90 | 2.9% | 22.73 |
| M008 | Health and safety | 30 | 50 | 40 | 195 | 78.75 | 2.6% | 77.93 |
| M010 | Teamworking | 132 | 95 | 130 | 240 | 149.25 | 4.8% | 62.84 |
| | **Core Competencies** | | | | | | | |
| T010 | Commercial management of construction | 50 | 105 | 120 | 10 | 71.25 | 2.3% | 50.72 |
| T017 | Contract practice | 373 | 190 | 240 | 90 | 223.25 | 7.2% | 117.71 |
| T013 | Construction technology and environmental services | 377 | 597 | 655 | 1090 | 679.75 | 22.0% | 298.56 |
| T022 | Design economics and cost planning | 230 | 280 | 230 | 270 | 252.5 | 8.2% | 26.30 |
| T062 | Procurement and tendering | 216 | 253 | 130 | 130 | 182.25 | 5.9% | 62.20 |
| T067 | Project financial control and reporting | 65 | 55 | 63 | 55 | 59.5 | 1.9% | 5.26 |
| T074 | Quantification and costing of construction works | 380 | 520 | 430 | 390 | 430 | 13.9% | 63.77 |
| | **Optional Competencies** | | | | | | | |
| T008 | Capital allowances | 2 | 0 | 20 | 20 | 10.5 | 0.3% | 11.00 |
| M006 | Conflict avoidance, management and dispute resolution procedures | 91 | 30 | 120 | 30 | 67.75 | 2.2% | 45.17 |
| T016 | Contract administration | 50 | 60 | 82 | 60 | 63 | 2.0% | 13.52 |
| T020 | Corporate recovery and insolvency | 0 | 0 | 0 | 0 | 0 | 0.0% | 0.00 |
| T025 | Due diligence | 0 | 0 | 0 | 0 | 0 | 0.0% | 0.00 |
| T045 | Insurance | 30 | 10 | 0 | 0 | 10 | 0.3% | 14.14 |
| T063 | Programming and planning | 80 | 80 | 103 | 185 | 112 | 3.6% | 49.86 |
| TO66 | Project evaluation | 100 | 45 | 225 | 220 | 147.5 | 4.8% | 89.49 |
| T077 | Risk management | 60 | 15 | 110 | 20 | 51.25 | 1.7% | 44.04 |
| M009 | Sustainability | 100 | 150 | 265 | 150 | 166.25 | 5.4% | 69.93 |
| | **Total hours** | 2620 | 2810 | 3363 | 3540 | 3083.25 | 100.0% | 438.23 |
| | **Percentage coverage of competencies** | 77% | 85% | 73% | 79% | 78% | | 0.05 |

### 3.3.2 Comparative Analysis of Case Studies

The four case study competency mappings were collated and statistically analysed to develop the conceptual benchmark for mapping graduate level QS competencies. A summary of the Depth Mapping of case studies is provided in Table 2.1.

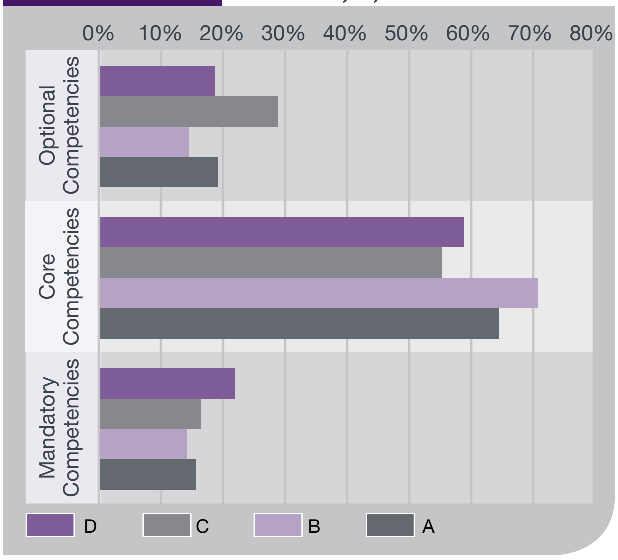
There are many variations in how the programme curricula of individual case studies (universities) are mapped to competencies. Most variations are in the mapping of a few core competencies and most optional competencies.

This is somewhat expected as individual programmes have their own strengths and character. The average total mapping of competencies stands at 78%, indicating that 22% of the curricula in undergraduate programmes reflects knowledge content that does not directly map against competencies. These are often fundamental and basic knowledge components that are essentially required in order to be able to deliver knowledge that would assist in the achievement of competencies.

A detailed analysis of the weightings for mandatory, core and optional competencies across the four case studies is presented in Figure 2.4.

It is very clear that all universities have given overwhelming priority to Core competencies. Two universities have given the second level of priority for either Optional or Mandatory competencies.

**Figure 2.4** Cross analysis of types of competencies for case studies A, B, C & D



## 3.4 Conceptual Benchmark for Graduate Route

The results of the previous research (Perera and Pearson, 2011) coupled with further issues identified from the literature and the competency mapping exercise formed the basis of the conceptual benchmark. The conceptual benchmark (see Table 2.2) is a two dimensional matrix reflecting overall average coverage and average depth of coverage of the four case studies. The conceptual benchmark values reflect the levels of achievement of competencies by graduates completing a degree from the four case study QS programmes. It reveals under Level 1 and Level 2 columns the topics covered in all the four RICS accredited degree programmes examined. A value of 1 against a particular topic implies that at least one of the case study degree programmes covers this. The Credits hours' column, which is the average of the four case study values, indicates typical expected times (in hours) devoted to each competency whilst the Percentage column shows the relative time proportion. Only a brief extract of the conceptual benchmark is shown in Table 2.2 as the table extends to several pages.

**Table 2.2** Sample of Conceptual Benchmark

| | Level 1 | Level 2 | Level 3 | Credits hours | Percentage |
|---|---|---|---|---|---|
| **Mandatory Competencies** | | | | | |
| **Accounting principles and procedures (M001) – Level 1** | | | | 3.75 | 0.1% |
| Balance sheets / profit and loss account | 0 | 0 | | | |
| Taxation | 1 | 0 | | | |
| Revenue and capital expenditure | 0 | 0 | | | |
| Cash flows | 1 | 0 | | | |
| Profitability | 1 | 0 | | | |
| Insolvency | 0 | 0 | | | |
| Legislation | 1 | 0 | | | |
| **Business planning (M002) – Level 1** | | | | 25 | 0.8% |
| Legislation | 1 | 0 | | | |
| Short / long term strategies | 1 | 0 | | | |
| Market analysis | 1 | 0 | | | |
| Five year plans | 1 | 0 | | | |
| Business support services – administration, secretarial, HR, IT etc. | 1 | 0 | | | |
| Staffing levels – recruitment / turnover | 1 | 0 | | | |
| Continued… | | | | | |
| **Core Competencies** | | | | | |
| **Commercial management of construction (T010) – Level 3** | | | | 71.25 | 2.3% |
| Estimating | 1 | 1 | | | |
| Establishing budgets | 1 | 1 | | | |
| Cash flows | 1 | 1 | | | |
| Reporting financial progress against budget | 1 | 1 | | | |
| Procurement of sub-contracts | 1 | 0 | | | |
| Financial management of supply chain | 1 | 0 | | | |
| Financial management of multiple projects | 1 | 0 | | | |

| | Level 1 | Level 2 | Level 3 | Credits hours | Percentage |
|---|---|---|---|---|---|
| **Core Competencies Cont.** | | | | | |
| **Contract practice (T017) – Level 3** | | | | 223.25 | 7.2% |
| Principles of contract law | 1 | 0 | | | |
| Legislation | 1 | 0 | | | |
| Current case-law – look out for cases reported in journals | 1 | 0 | | | |
| Standard forms of main and sub contract – e.g. JCT, NEC/ECC, GC Works, ICE, ACA, IChemE, FIDIC, etc. | 1 | 1 | | | |
| Final Accounts | 1 | 1 | | | |
| Completion | 1 | 0 | | | |
| Liquidated and Ascertained Damages | 1 | 0 | | | |
| Defects rectification period | 1 | 1 | | | |
| **Construction technology and environmental** services (T013) – Level 3 | | | | 679.75 | 22.0% |
| Construction technology | 1 | 0 | | | |
| Substructures – basements, types of piling, etc. | 1 | 0 | | | |
| Superstructures | 1 | 0 | | | |
| Comparison of concrete / steel frames | 1 | 0 | | | |
| External walls, windows and doors | 1 | 0 | | | |
| Cladding / glazing | 1 | 0 | | | |
| Planning legislation and procedures | 0 | 0 | | | |
| Party wall issues / rights of light | 0 | 0 | | | |
| Dangerous / banned substances – asbestos etc | 0 | 0 | | | |
| Pre-fabrication | 1 | 0 | | | |
| Disability legislation | 1 | 0 | | | |
| **Design economics and cost planning (T022) – Level 3** | | | | 252.5 | 8.2% |
| Economics of design – site density, wall / floor ratio, storey heights, room sizes, letable / non-letable | 1 | 1 | | | |
| Sources of cost data – BCIS / in-house database / other external sources | 1 | 1 | | | |
| Inflation (tender / construction) | 1 | 1 | | | |
| Location factors, regional variations | 1 | 1 | | | |
| Currency fluctuations | 1 | 0 | | | |
| Estimating | 1 | 1 | | | |
| Cost Plans | 1 | 1 | | | |
| Cost Planning | 1 | 1 | | | |
| Life cycle costing - capital / running costs / replacement | 1 | 1 | | | |
| Value Engineering | 1 | 1 | | | |
| Value Management | 1 | 1 | | | |
| Continued... | | | | | |
| **Optional Competencies** | | | | | |
| **Capital allowances (T008)** | | | | 10.5 | 0.3% |
| Current legislation | 1 | 0 | | | |
| Capital and revenue expenditure | 1 | 0 | | | |

| | Level 1 | Level 2 | Level 3 | Credits hours | Percentage |
|---|---|---|---|---|---|
| **Optional Competencies Cont.** | | | | | |
| Taxation | 1 | 0 | | | |
| Capital Allowances legislation | 1 | 0 | | | |
| Claiming capital allowances | 1 | 0 | | | |
| Plant and machinery | 1 | 0 | | | |
| Enhanced capital allowances | 0 | 0 | | | |
| **Conflict avoidance, management and dispute resolution procedures (M006)** | | | | 67.75 | 2.2% |
| How standard forms of contract deal with conflict avoidance and dispute resolution | 1 | 0 | | | |
| Conflict avoidance | 1 | 0 | | | |
| Partnering | 1 | 0 | | | |
| Negotiation | 1 | 0 | | | |
| Mediation | 1 | 0 | | | |
| Conciliation | 1 | 0 | | | |
| Adjudication | 1 | 0 | | | |
| Arbitration | 1 | 0 | | | |
| Expert Witness | 1 | 0 | | | |
| Continued... | | | | | |
| | **298** | **99** | | **3083.25** | **100.0%** |

On the whole, the conceptual benchmark shows the average level of graduate competency achievement from four RICS accredited programmes. The conceptual benchmark indicates graduate attainment of RICS QS competencies. This provided a basis for further investigation of industry and academic views of the conceptual benchmark and their expectations.
This is essential to harmonise diverse views and to generate a minimum graduate competency benchmark that satisfies the aspirations of all stakeholders.

**Table 2.3** Summarised Conceptual Benchmark – Depth & Breadth Scales

| | | Depth scale | | Breadth Scale | |
|---|---|---|---|---|---|
| | | Learning Hours | | % Coverage of topics | |
| | | Average | Time % | Level 1 | Level 2 |
| **Mandatory Competencies** | | | | | |
| M001 | Accounting principles and procedures | 3.75 | 0.1% | 80.0% | 0.0% |
| M002 | Business planning | 25 | 0.8% | 100.0% | 0.0% |
| M003 | Client care | 32.5 | 1.1% | 75.0% | 50.0% |
| M004 | Communication and negotiation | 148.5 | 4.8% | 100.0% | 87.5% |
| M005 | Conduct rules, ethics and professional practice | 28.75 | 0.9% | 64.3% | 14.3% |
| M007 | Data management | 90 | 2.9% | 100.0% | 71.4% |
| M008 | Health and safety | 78.75 | 2.6% | 100.0% | 0.0% |
| M010 | Teamworking | 149.25 | 4.8% | 100.0% | 75.0% |
| **Core Competencies** | | | | | |
| T010 | Commercial management of construction | 71.25 | 2.3% | 100.0% | 55.6% |
| T017 | Contract practice | 223.25 | 7.2% | 100.0% | 42.9% |
| T013 | Construction technology and environmental services | 679.75 | 22.0% | 85.7% | 0.0% |
| T022 | Design economics and cost planning | 252.5 | 8.2% | 100.0% | 73.3% |
| T062 | Procurement and tendering | 182.25 | 5.9% | 92.3% | 15.4% |
| T067 | Project financial control and reporting | 59.5 | 1.9% | 100.0% | 30.0% |
| T074 | Quantification and costing of construction works | 430 | 13.9% | 95.2% | 38.1% |
| **Optional Competencies** | | | | | |
| T008 | Capital allowances | 10.5 | 0.3% | 58.3% | 0.0% |
| M006 | Conflict avoidance, management and dispute resolution procedures | 67.75 | 2.2% | 100.0% | 0.0% |
| T016 | Contract administration | 63 | 2.0% | 95.5% | 9.1% |
| T020 | Corporate recovery and insolvency | 0 | 0.0% | 15.4% | 0.0% |
| T025 | Due diligence | 0 | 0.0% | 20.0% | 0.0% |
| T045 | Insurance | 10 | 0.3% | 50.0% | 0.0% |
| T063 | Programming and planning | 112 | 3.6% | 100.0% | 50.0% |
| TO66 | Project evaluation | 147.5 | 4.8% | 100.0% | 76.9% |
| T077 | Risk management | 51.25 | 1.7% | 84.6% | 53.8% |
| M009 | Sustainability | 166.25 | 5.4% | 100.0% | 8.3% |
| **Total** | | **3083.25 hours** | **100.0%** | **290 topics** | **93 topics** |

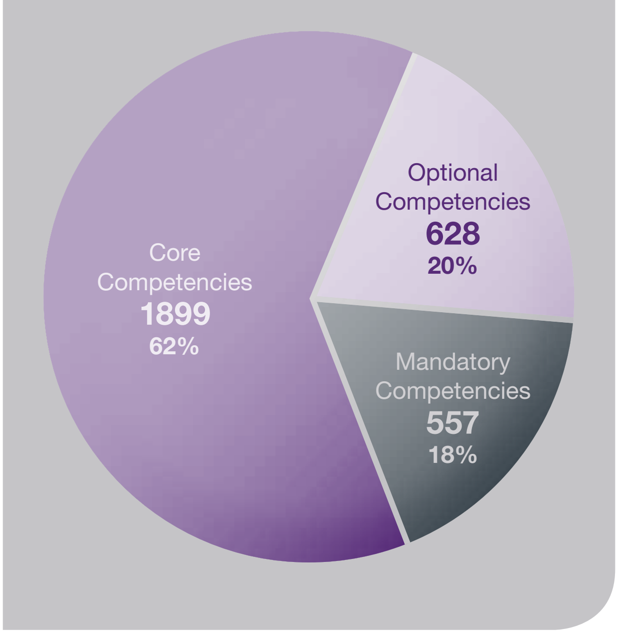
In order to provide a meaningful comparison of the priorities of the Conceptual Benchmark the summary of the depth and breadth scales for competencies is provided in Table 3.3.

This table is derived from obtaining average figures from the four case studies completed. The Depth scale was developed using mean time periods utilised for each competency. The Breadth scale was developed by considering the frequency of engagement with the topics in the study checklist and considering at least dealing with a topic once by any of the case study programmes (considered as 1 – contributing to the count). There are 290 topics used across 4 case studies at Level 1 and 93 at Level 2. This does not necessarily imply that any one case study (university) used all 290 topics identified here. The total of 290 and 93 for Level 1 and 2 respectively indicate the maximum number of topic dealt with across four case studies.

The core competencies have the greatest weightage with 62% share followed by optional competencies with 20% and mandatory competencies with 18% share (Figure 2.4). There are a total of 3083 hours of learning representing 86% of learning time for a programme.

The conceptual benchmark provides the basis of development of the final benchmark for graduate level competencies. It was presented to the expert forum for revision. The process is fully described in the following section.

**Figure 2.5** Conceptual Benchmark – Weightage of competencies



## 3.5 Development of the Final Benchmark for Graduate Route

The conceptual benchmark was presented to a selected expert forum for revision of both breadth and depth scales for all study topics and competencies. Using the Delphi methodology the views of experts were harmonised to create the final benchmark. The process is explained in detail in the following sections.

### 3.5.1 Pilot Study

A two stage pilot study involving two experts was carried out to develop the framework for the conduct of the expert forum. The two experts selected were:

1. A very experienced senior academic
2. A very experienced senior practitioner with experience in both consulting and contracting practices.

The aim of the pilot study was twofold:

1. Further develop the map scoring system developed to carry out the competency mapping case studies and establish the conceptual benchmark. This was stage one of the pilot study process.
2. Carry out a preliminary run of the expert forum interviews in presenting conceptual benchmark and obtaining their views. This process helped in the development of the interview process to collect data for the revision of the conceptual benchmark. This was the second stage of the pilot study.

On completion of the pilot study the process protocol to follow in the expert forum was developed.

### 3.5.2 Establishing the Expert Forum

The forum of experts consists of industry practitioners from large, SME and micro level quantity surveying organisations. These include quantity surveying employer organisations from both the traditional consulting and contracting sectors. A minimum of two experts from each category were sought for this exercise. In addition, three Quantity Surveying programme directors from RICS accredited programmes were also invited to participate. All members were experienced academics and chartered surveyors. The forum consisted of 15 members representing all types of quantity surveying employers and academics (Table 2.4).

**Table 2.4** The composition of the Expert Forum

| | Type of Organisation | Abbreviation | Size | Code |
|---|---|---|---|---|
| 1 | Consulting practice | PQS | Large | L |
| 2 | Consulting practice | PQS | Large | D |
| 3 | Consulting practice | PQS | SME | G |
| 4 | Consulting practice | PQS | SME | E |
| 5 | Consulting practice | PQS | Micro | F |
| 6 | Consulting practice | PQS | Micro | B |
| 7 | Contracting | CQS | Large | Q |
| 8 | Contracting | CQS | Large | K |
| 9 | Contracting | CQS | SME | A |
| 10 | Contracting | CQS | SME | J |
| 11 | Contracting | CQS | Micro | C |
| 12 | Contracting | CQS | SME | H |
| 13 | Academia | Academic | University | N |
| 14 | Academia | Academic | University | M |
| 15 | Academia | Academic | University | P |

### 3.5.3 Revision and the Ratification of the Benchmark

The stages followed in the expert forum are given below:

1. Invitations to industry and academic experts to join expert forum.
2. Appoint the expert forum members.
3. Arrange and conduct individual expert forum interviews arranged to obtain views on revisions to the conceptual benchmark.
4. Collate views of the expert forum and develop the revised benchmark considering the average views of all experts.
5. Distribute the revised benchmark to all experts to obtain views on further revisions or concurrence with the revised benchmark.
6. Collate all further revisions to develop the ratified benchmark.
7. Convert the ratified benchmark to the final benchmark (GCTB).

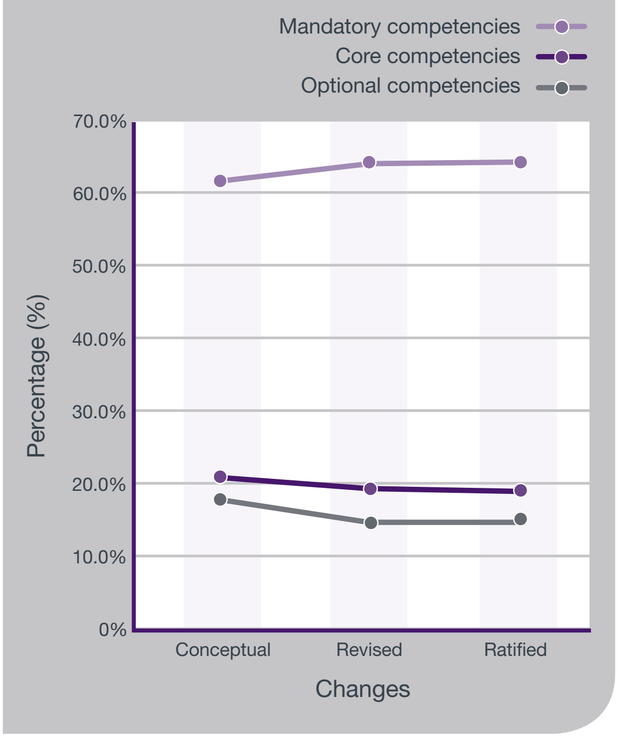
The details of how the revised benchmark values were developed from the conceptual benchmark are explained below. A similar pattern was followed for the development of the ratified benchmark values from the revised benchmark.

For the breadth scale, mode was used to analyse expert forum views. A competency consists of several topics. At Level 1, a topic under a certain competency can either be expected (i.e. by the experts) to be covered (i.e. marked as 1) or not expected to be covered (i.e. marked as 0), in graduate QS education. Same rules apply to Level 2 coverage. Level 3 is not considered because it is not a typical level of attainment in graduate QS education.

The mode of the 15 experts' views is then derived for each topic at both Level 1 and Level 2. For example, if 8 experts (hence 8 ticks) or more think that a topic should be covered in graduate QS education at Level 1, the topic is marked as 1 under Level 1, and vice versa. Same applies to Level 2 coverage. The number of topics covered under each competency, marked as 1, is then used to calculate the percentage coverage of topics for that competency, at both Level 1 and Level 2.

The average views of all experts were used for the depth scale. The experts were asked to amend the conceptual benchmark values i.e. credits hours to reflect the learning hours they think should be allocated to each competency in graduate QS education. The mean value of the 15 expert forum views on credits hours was then computed for each competency. The mean figure is converted to percentage score to illustrate the relative time proportion for each competency.

**Figure 2.6** **Summary of changes to the benchmark**



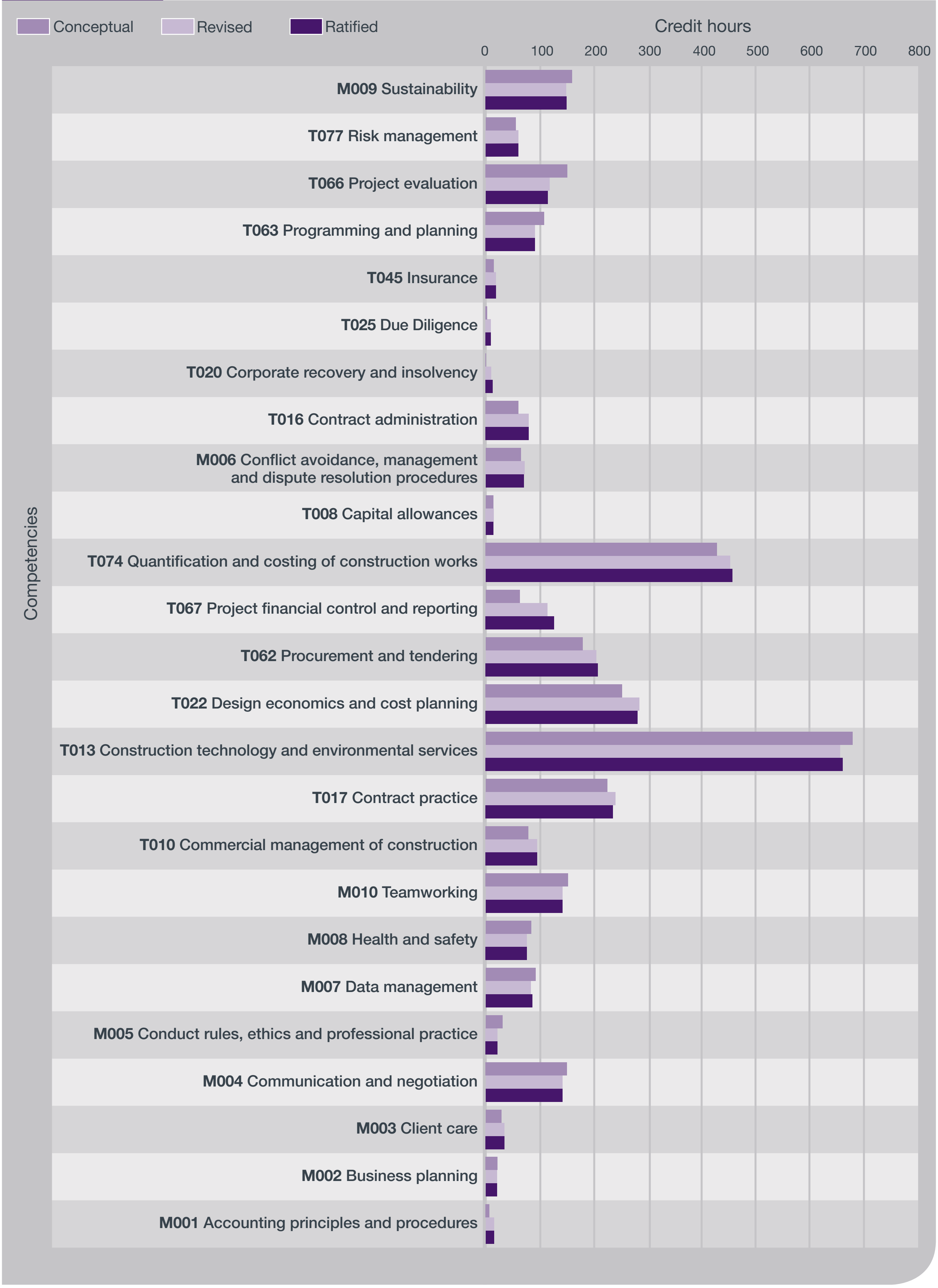

The Delphi technique (Rowe and Wright, 2001) was utilised to extract and harmonise the views of the experts. This enabled the researchers to achieve a consensus view from the forum to finalise the benchmark minimum levels of achievement of competencies for graduate quantity surveyors.

A comparison of the conceptual, revised and ratified benchmarks using the depth scale is presented in Figure 2.7.

It is clear that there were some changes from a conceptual benchmark to a revised benchmark but there were minimal changes from the revised to the ratified benchmark (final GCTB).

The changes to the benchmark through the revision and ratification processes are summarised in Figure 2.6. This indicates a slight increase in the weighting for core competencies and a corresponding relative decrease in mandatory and core competencies. This also reflects a 3% increase in the total number of learning hours from 3083 hours to 3188 hours.

**Figure 2.7** Cross comparison of ratified, revised and conceptual benchmarks for graduate competencies



## 4.1 The GCTB – Final Benchmark

The final ratified benchmark with the dual scale breadth and depth mappings is converted to create the final Graduate competency threshold benchmark (GCTB). The full details of the GCTB are presented in (Appendix A). GCTB is a minimum threshold benchmark. Therefore it represents minimum levels of competency achievement. A summarised version of the final benchmark (GCTB) is presented in Table 2.5 below.

The benchmark is expressed in hours rather than in credits to enable each competency to be distributed and mapped against multiple modules (if required).

**Table 2.5** Summarised final benchmark (GCTB)

| | | Depth scale | | Breadth Scale | |
|---|---|---|---|---|---|
| | GCTB | Learning Hours | | % Coverage of topics | |
| Code | Competency | Ratified | Time % | Level 1 | Level 2 |
| C1 | Mandatory Competencies | | | | |
| C1.1 | M001 Accounting principles and procedures | 10 | 0.3% | 80% | 0% |
| C1.2 | M002 Business planning | 24 | 0.8% | 100% | 0% |
| C1.3 | M003 Client care | 36 | 1.1% | 75% | 50% |
| C1.4 | M004 Communication and negotiation | 138 | 4.3% | 100% | 88% |
| C1.5 | M005 Conduct rules, ethics and professional practice | 26 | 0.8% | 64% | 14% |
| C1.6 | M007 Data management | 82 | 2.6% | 100% | 71% |
| C1.7 | M008 Health and safety | 72 | 2.3% | 100% | 0% |
| C1.8 | M010 Teamworking | 133 | 4.2% | 100% | 75% |
| C2 | Core Competencies | | | | |
| C2.1 | T010 Commercial management of construction | 96 | 3.0% | 100% | 56% |
| C2.2 | T017 Contract practice | 243 | 7.6% | 100% | 43% |
| C2.3 | T013 Construction technology and environmental services | 660 | 20.7% | 86% | 0% |
| C2.4 | T022 Design economics and cost planning | 275 | 8.6% | 100% | 73% |
| C2.5 | T062 Procurement and tendering | 203 | 6.4% | 92% | 15% |
| C2.6 | T067 Project financial control and reporting | 121 | 3.8% | 100% | 30% |
| C2.7 | T074 Quantification and costing of construction works | 462 | 14.5% | 95% | 38% |
| C3 | Optional Competencies | | | | |
| C3.1 | T008 Capital allowances | 11 | 0.3% | 58% | 0% |
| C3.2 | M006 Conflict avoidance, management and dispute resolution procedures | 70 | 2.2% | 100% | 0% |
| C3.3 | T016 Contract administration | 81 | 2.5% | 96% | 9% |
| C3.4 | T020 Corporate recovery and insolvency | 10 | 0.3% | 15% | 0% |
| C3.5 | T025 Due Diligence | 6 | 0.2% | 20% | 0% |
| C3.6 | T045 Insurance | 13 | 0.4% | 50% | 0% |
| C3.7 | T063 Programming and planning | 97 | 3.0% | 100% | 50% |
| C3.8 | T066 Project evaluation | 118 | 3.7% | 100% | 77% |
| C3.9 | T077 Risk management | 58 | 1.8% | 85% | 54% |
| C3.10 | M009 Sustainability | 144 | 4.5% | 100% | 8% |
| | Total | 3188 hours | 100.0% | 305 topics | 102 topics |

The percentage time allocation clearly indicates the relative importance of competencies in terms of learning hours that need to be spent at undergraduate level. The relative importance of competency categories is presented in Figure 2.8.

The overall levels of coverage of topics for mandatory, core and optional competencies are summarised in Figure 2.9. It is clear that most topics, especially for mandatory and core competencies, need to be covered at Level 1. There is a slightly higher coverage for mandatory competencies over core competencies which are expected at Level 2.

The depth scale indicates the minimum number of learning hours that needs to be allocated to each competency in a RICS accredited QS honours degree programme. The module specifications of such a programme can be mapped to the RICS QS competencies, identifying the learning hours spent for each competency. The minimum benchmark developed here provides a threshold minimum to achieve in this mapping (Figure 10).

The breadth scale (Figure 11) in the benchmark indicates the expected percentage coverage of the RICS QS Study Check list (RICS, 2008a). The detail of which study topics need to be covered is indicated in the full benchmark presented in Appendix A of this report.

## 4.2 An in depth Analysis of the Benchmark and Expert Forum Perspectives

The expert forum consisted of 3 main groups of experts viz PQS, CQS and Academics. Figure 12 presents a cross analysis of these groups' views against combined views (Ratified).

It is clear that there is a minimal difference of opinion between these groups. Since all three expert forum groups have expressed similar views, this is reflected in the combined view expressed in the ratified benchmark.

**Figure 2.8** Relative time allocations for competency categories

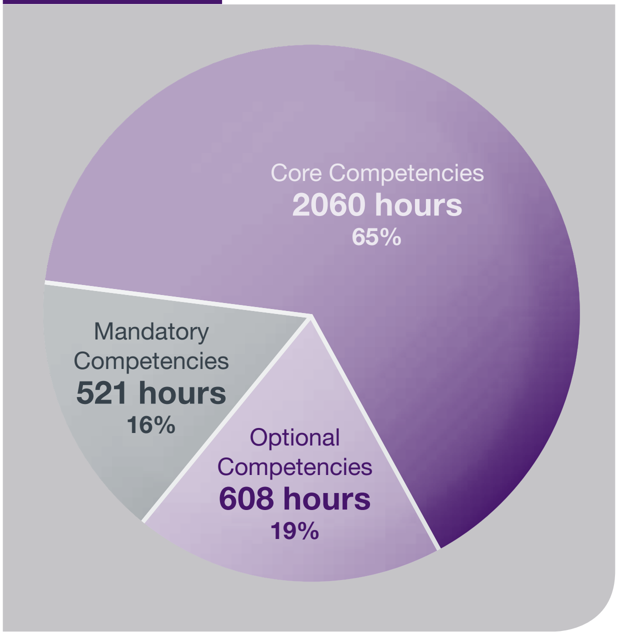



**Figure 2.9** Overall comparison of coverage of topics (Breadth scale) across competency categories

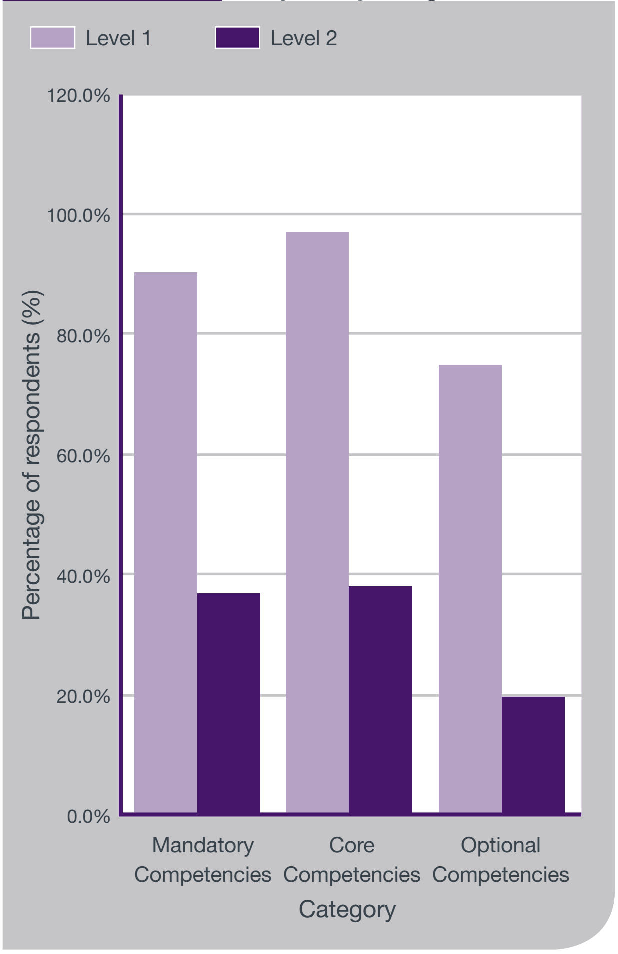


**Figure 2.10** Benchmark minimum learning hours – Depth scale

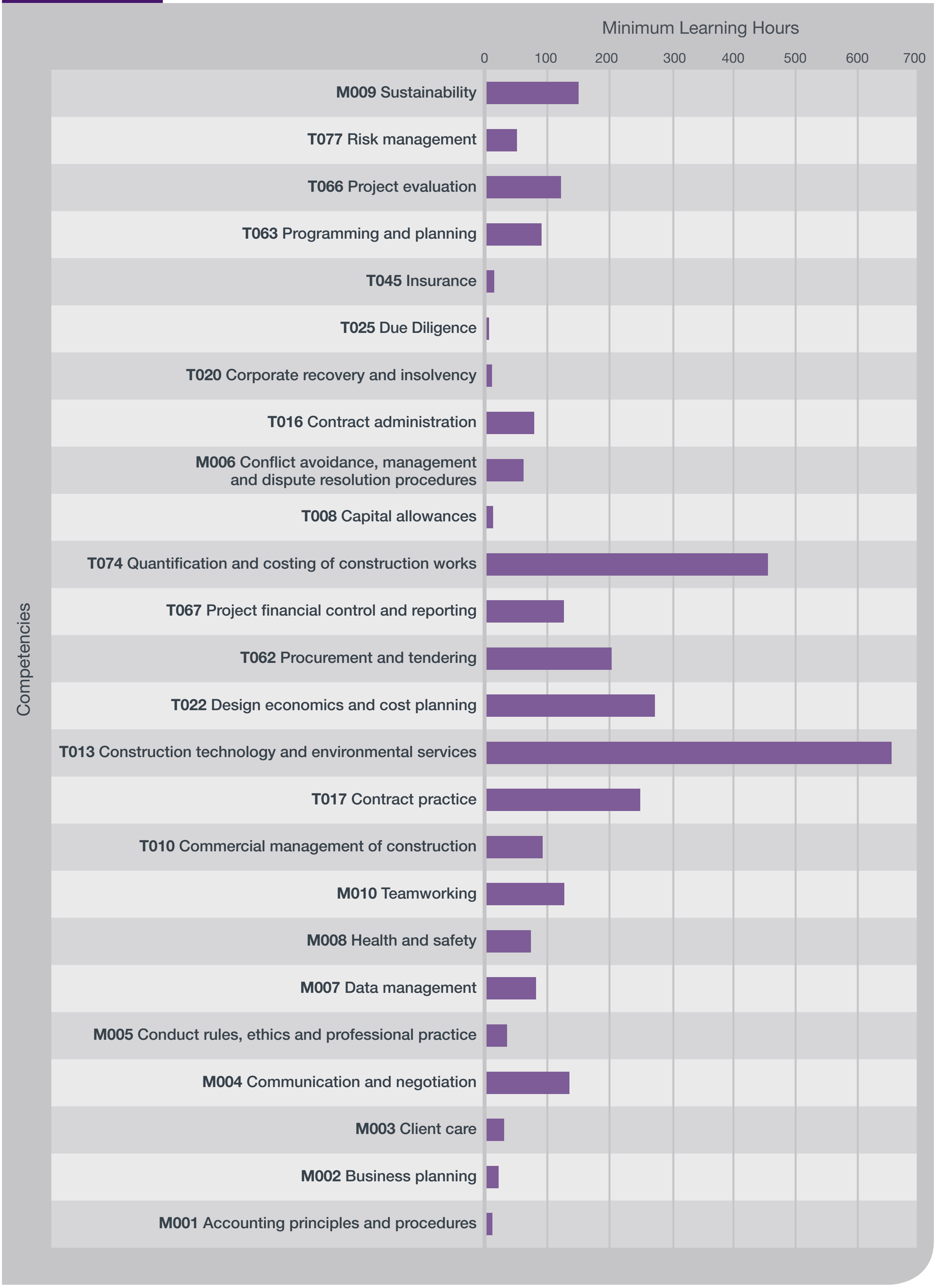


Figure 2.11 Benchmark minimum coverage of study topics – Breadth scale

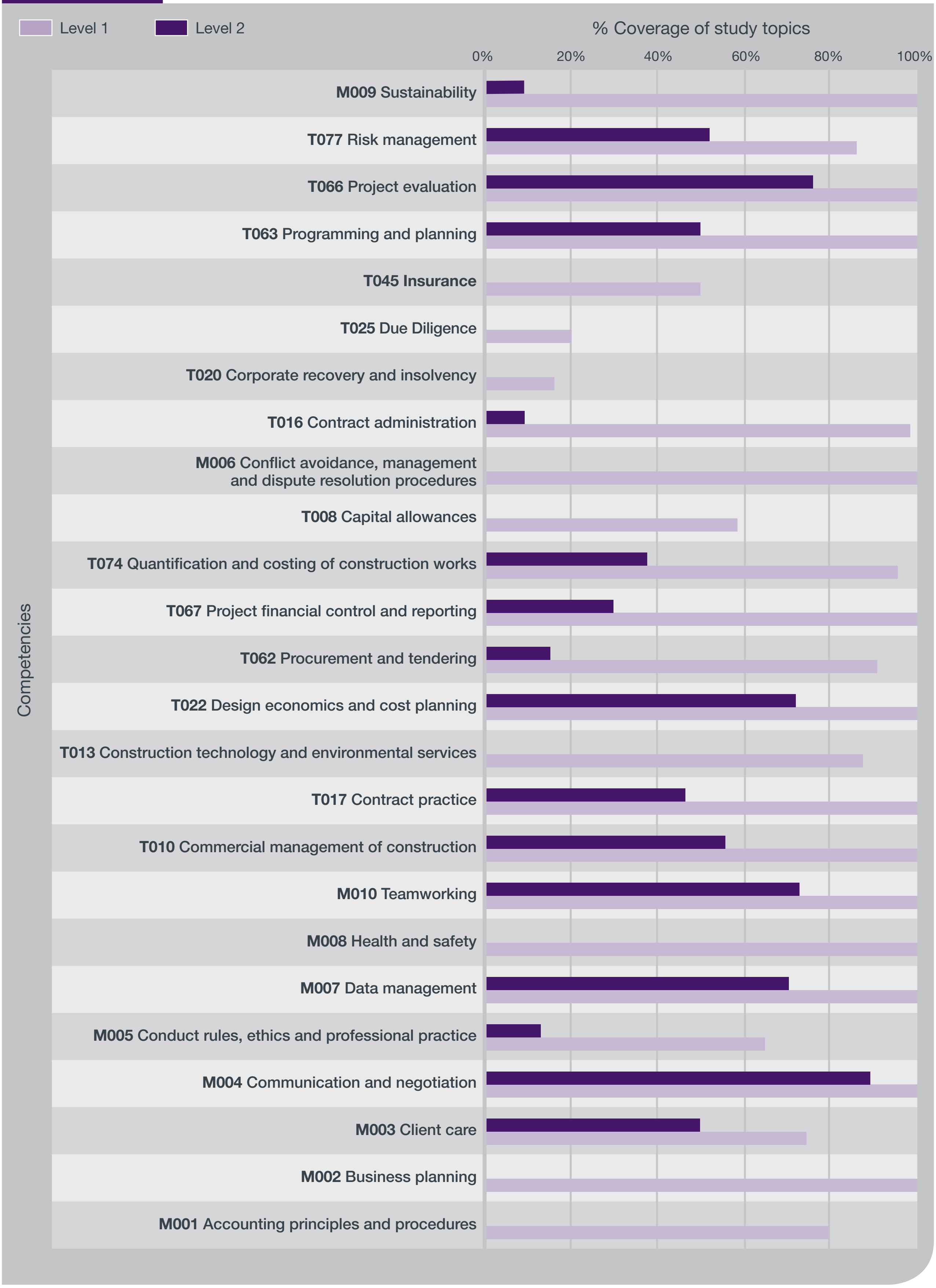
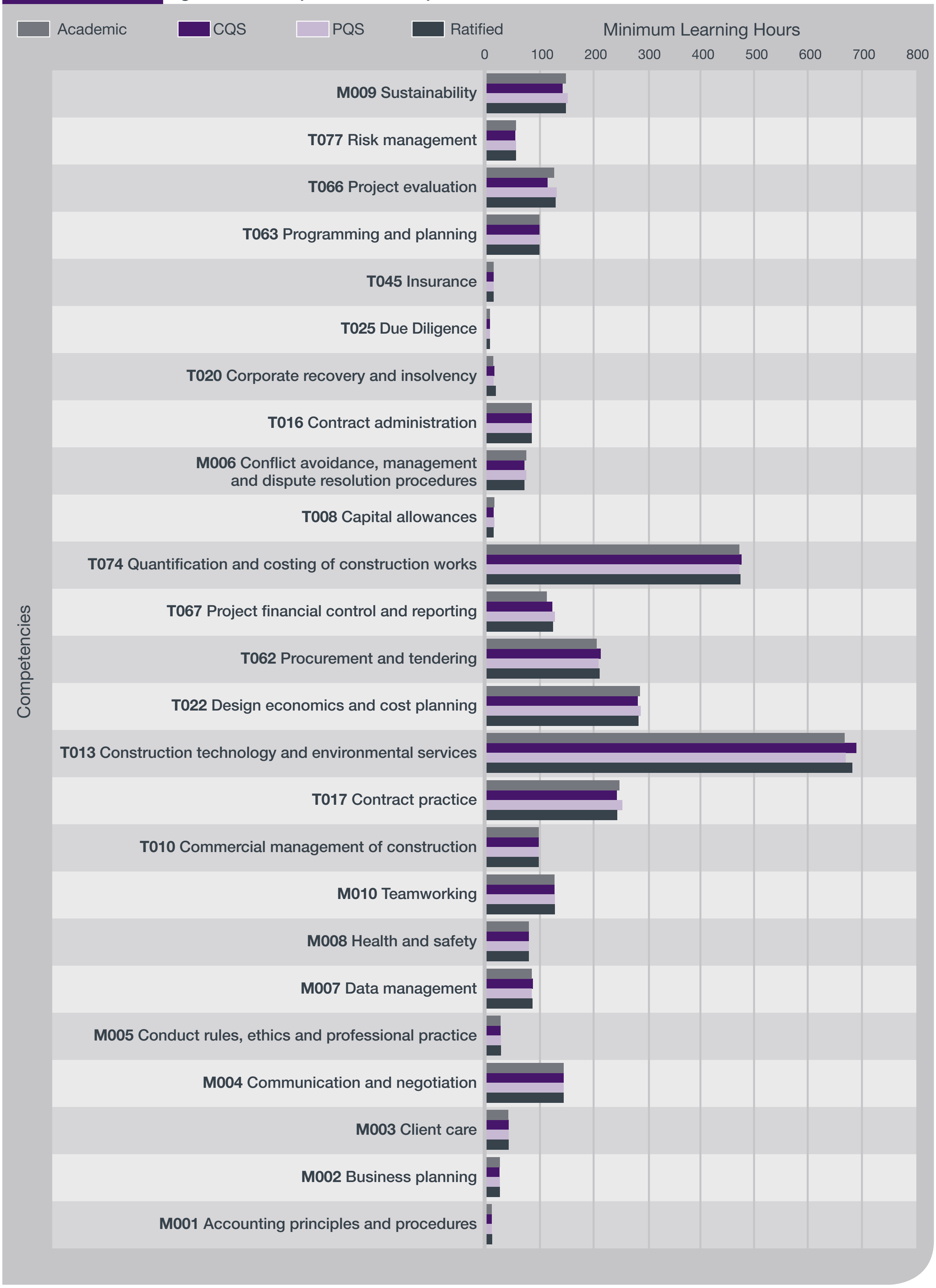


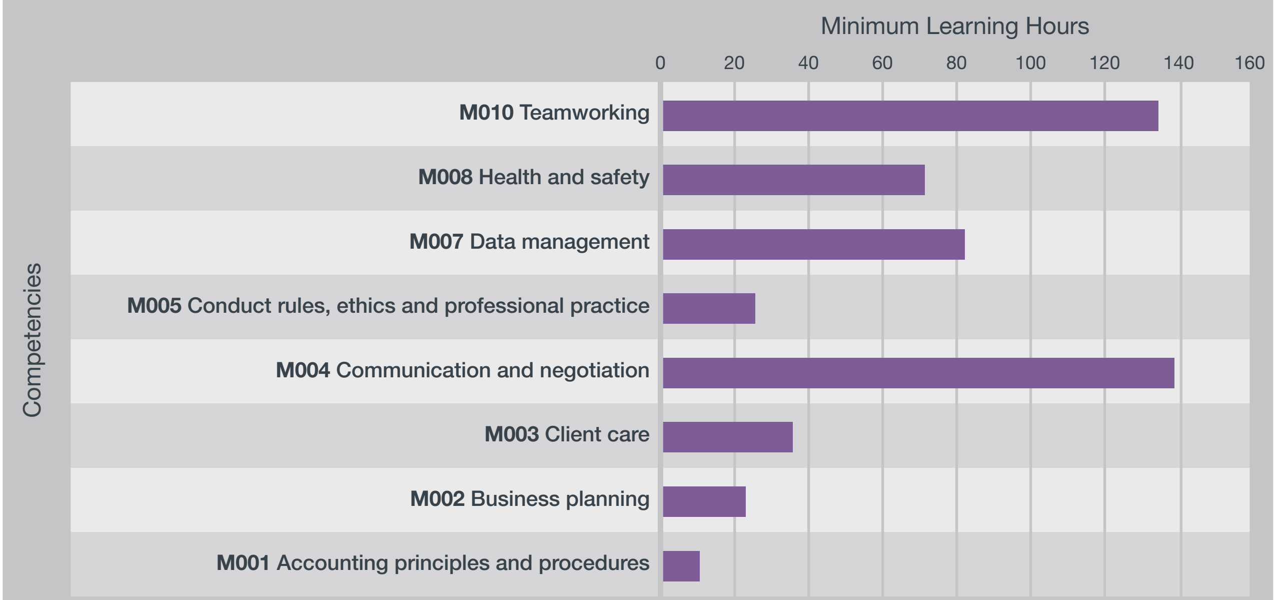
**Figure 2.12** Cross analysis of views of expert forum groups (PQS, CQS & Academics) against ratified (combined view)



## 4.3 Analysis of Mandatory Competencies

Mandatory competencies are general competencies that are essential for the performance of the services of chartered QS. There are altogether 8 mandatory competencies, which are analysed in both Depth scale – minimum amount of time that a graduate should spend in learning aspects related to mandatory competencies and Breadth scale – the extent of coverage of competencies by study topics.

**Figure 2.13** **Minimum benchmark learning hours – Mandatory competencies**




| | M010 Teamworking | M008 Health and safety | M007 Data management | M005 Conduct rules, ethics and professional practice | M004 Communication and negotiation | M003 Client | M002 Business planning | M001 Accounting principles and procedures |
|---|---|---|---|---|---|---|---|---|
| **Percentage** | 2% | 5% | 7% | 26% | 5% | 16% | 14% | 26% |
| **Minimum Hours** | 10 | 24 | 36 | 138 | 26 | 82 | 72 | 133 |

## 4.3.1 Analysis of Mandatory Competencies by Depth Scale

The 8 mandatory competencies are analysed in Depth scale (time spent on learning) in this section. Figure 13 illustrates the minimum study hours stipulated for achievement of mandatory competencies at graduate level.

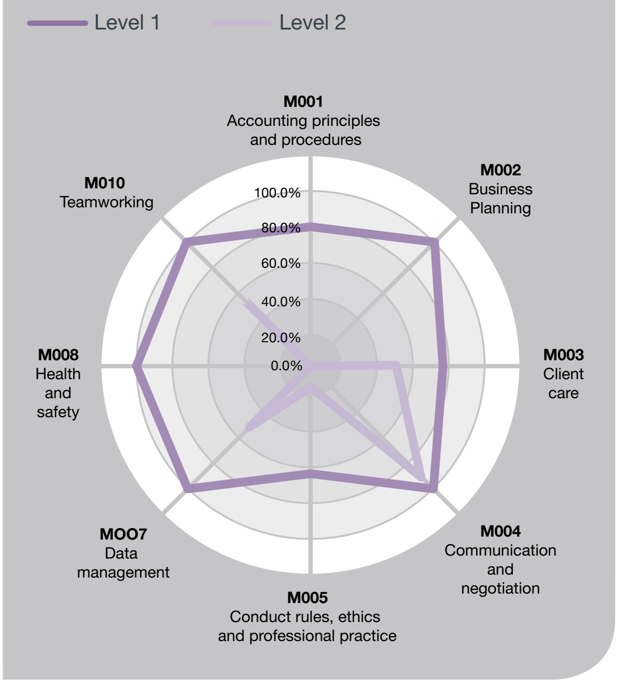
M004 Communication and negotiation and M010 Teamworking are the two most important competencies and require over 130 hours (13 credits) of learning coverage. These two are followed by M007 Data management with 82 hours (8 credits) and M008 Health and Safety with 72 hours (7 credits). Other competencies are stipulated as of a very low level of importance.

## 4.3.2 Analysis of Mandatory Competencies by Breadth Scale

The expected coverage of study topics by respective competency is analysed in this section. Figure 2.14 illustrates the minimum coverage of study topics required for achievement of mandatory competencies at graduate level.

Except for M001 Accounting principles and procedures, M003 Client care, and M005 Conduct rules, ethics and professional practice competencies, full coverage of study topics in all other competencies are expected at Level 1. Coverage of topics at Level 2 is also expected for 70% or more for M004 Communication and negotiation, M010 Teamworking, and M007 Data management competencies.

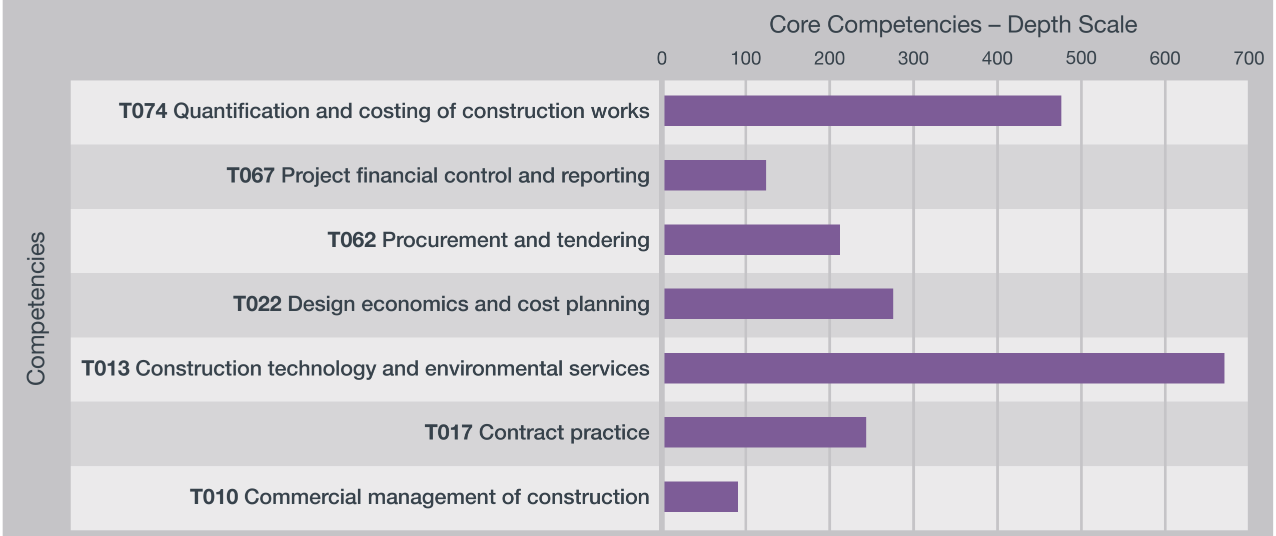
**Figure 2.14** **Minimum benchmark coverage of study topics – Mandatory Competencies**



## 4.4 Analysis of Core Competencies

The Core competencies are the most essential in providing QS services and signify core functions of the QS. There are altogether 7 core competencies that need to be achieved. These are analysed in both Depth scale – minimum amount of time that a graduate should spend in learning aspects related to mandatory competencies and Breadth scale – the extent of coverage of competencies by study topics.

**Figure 2.15** **Minimum benchmark learning hours - Core competencies**




| | T010 Commercial management of construction | T017 Contract practice | T013 Construction technology and environmental services | T022 Design economics and cost planning | T062 Procurement and tendering | T067 Project financial control and reporting | T074 Quantification and costing of construction works |
|---|---|---|---|---|---|---|---|
| Percentage | 5% | 12% | 32% | 13% | 10% | 6% | 22% |
| Minimum Hours | 96 | 243 | 660 | 275 | 203 | 121 | 462 |

## 4.4.1 Analysis of Core Competencies by Depth Scale

The 7 core competencies are analysed in Depth scale (time spent on learning) in this section. Figure 15 illustrates the minimum study hours stipulated for achievement of core competencies at graduate level.

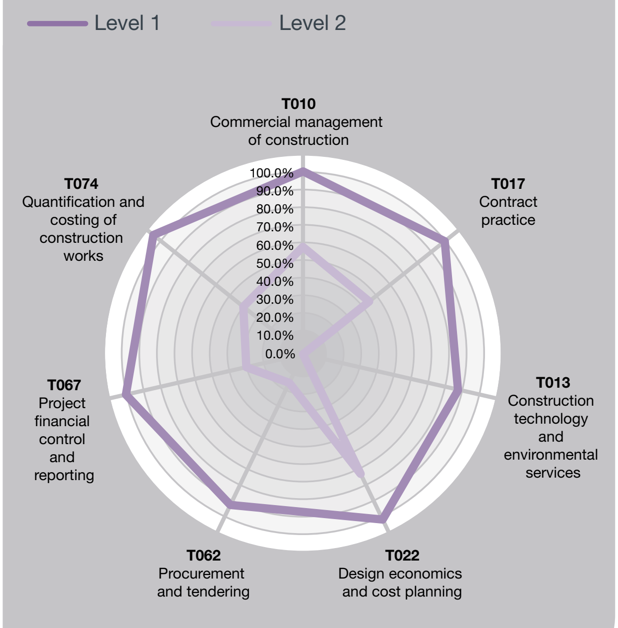
T013 Construction technology and environmental services, is considered the single most important competence that needs to be achieved at graduate level education. It has a 32% weighting in time commitment, with 660 hours' time allocated for the competence. This equates to 21% (66 credits) of an honours degree programme. The second most important competence in terms of time allocation is the T074 Quantification and costing of construction works, with 462 hours (46 credits) of time allocation. It is followed by T022 Design economics and cost planning, with 275 hours (28 credits), T017 Contract practice, with 243 hours (24 credits) and, T062 Procurement and tendering, with 203 hours (20 credits). These levels of importance corroborate well with importance rankings in previous research (Perera & Pearson, 2011).

## 4.4.2 Analysis of Core Competencies by Breadth Scale

The expected coverage of study topics by respective competency is analysed in this section. Figure 16 illustrates the minimum coverage of study topics required for the achievement of core competencies at graduate level.

Almost 100% coverage of study topics is expected at Level 1 in all competencies except for T013 Construction technology and environmental services, T062 Procurement and tendering, and T074 Quantification and costing of construction works competencies. Even in these over 85% coverage is expected. At Level 2, over 73% coverage of topics is expected for T022 Design economics and cost planning, with the second highest on T010 Commercial management of construction (55%). This indicates that these two topics have the highest level of importance in terms of topic coverage. However, there is relative lesser emphasis on these two aspects in the Depth scale analysis.

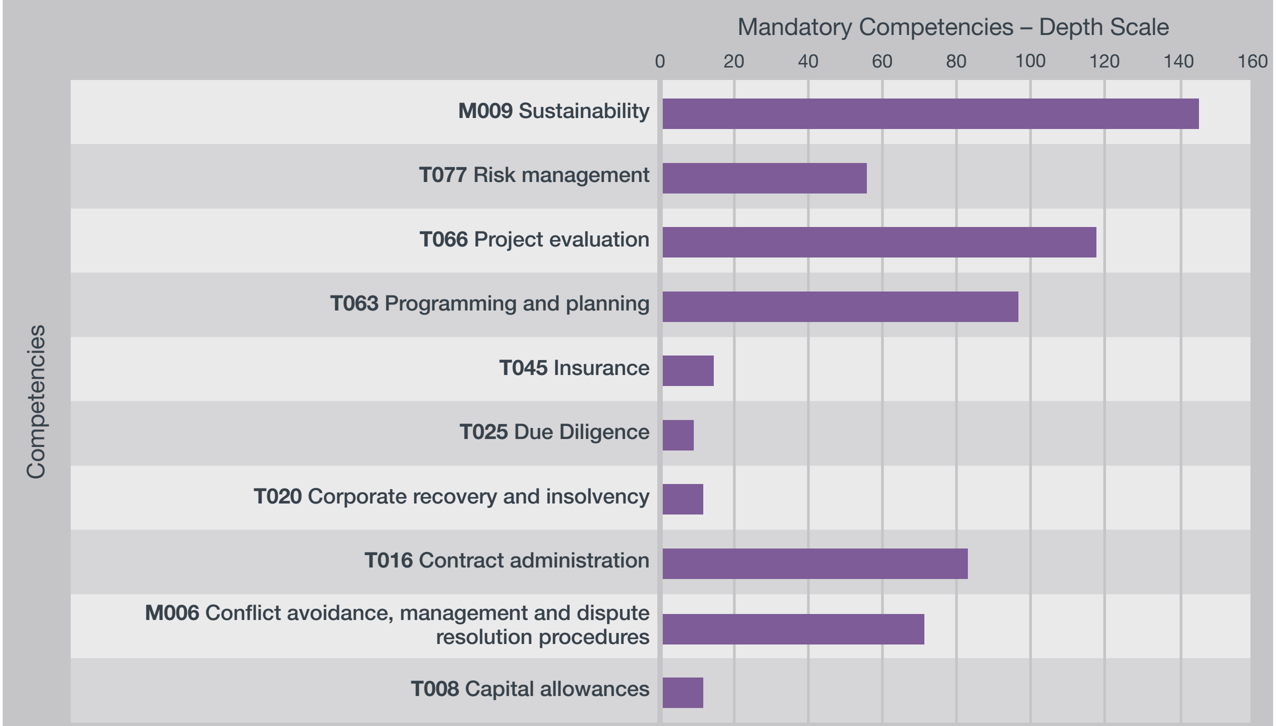
**Figure 2.16** **Minimum benchmark coverage of study topics – Core Competencies**



## 4.5 Analysis of Optional Competencies

Optional competencies define the add-on and peripheral functions of the QS. These are important in expanding and providing modern QS services. There are altogether 10 optional competencies that need to be achieved. These are analysed in both Depth scale – minimum amount of time that a graduate should spend in learning aspects related to mandatory competencies, and Breadth scale – the extent of coverage of competencies by study topics.

**Figure 2.17** **Minimum benchmark learning hours – Optional Competencies**




| | T008 Capital allowances | M006 Conflict avoidance, management and dispute resolution procedures | T016 Contract administration | T020 Corporate recovery and insolvency | T025 Due Diligence | T045 Insurance | T063 Programming and planning | T066 Project evaluation | T077 Risk management | M009 Sustainability |
|---|---|---|---|---|---|---|---|---|---|---|
| **Percentage** | 2% | 12% | 13% | 2% | 1% | 2% | 16% | 19% | 10% | 24% |
| **Minimum Hours** | 11 | 70 | 81 | 10 | 6 | 13 | 97 | 118 | 58 | 144 |

## 4.5.1 Analysis of Optional Competencies by Depth Scale

The 10 optional competencies are analysed in Depth scale (time spent on learning) in this section. Figure 2.17 illustrates the minimum study hours stipulated for achievement of optional competencies at graduate level.

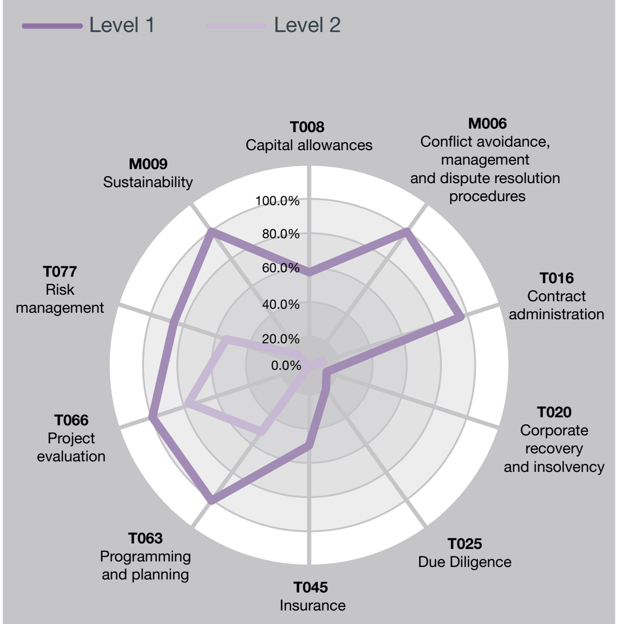
M009 Sustainability, with 144 hours (14 credits) is the most important optional competency in terms of learning time allocation. This is followed by T066 Project evaluation, with 118 hours (12 credits), T063 Programming and planning, with 97 hours (10 credits) and T016 Contract administration, with 81 hour (8 credits). This is very much to be expected and mostly corroborates with previous research (Perera & Pearson, 2011). However, there are two main anomalies in that T016 Contract administration has been pushed down in importance.

## 4.5.2 Analysis of Optional Competencies by Breadth Scale

The expected coverage of study topics by respective competency is analysed in this section. Figure 2.18 illustrates the minimum coverage of study topics required for the achievement of optional competencies at graduate level.

At Level 1, there are three competencies that require coverage of topics at 100%. All other competencies require coverage at much lower levels. The competencies T063 Programming and planning, T066 Project evaluation and T077 Risk management, require over 50% coverage of topics at Level 2.

**Figure 2.18** Minimum benchmark coverage of study topics - Optional Competencies



# 5.0 Competency Mapping Framework in the context of existing Processes

In this section, current academic and RICS processes and structures will be reviewed, in order to set the introduction and operation of the proposed benchmarking system within these. The review is based on an examination of available literature and interviews of three academics with extensive experience in QS programme development and management. The views of the interviewees are presented using numbers 1, 2 and 3 representing their respective views. The interviews were semi structured to enable free discussion but within the parameters of the report.

## 5.1 Programme Development and Validation

### 5.1.1 Introduction

The current network of Quantity Surveying Degrees grew from the early 1970's with the move from Diploma to Degree level qualification for entry to the profession. The following examines the general processes required of those seeking validation of a new programme or re-validation of an existing, considering how a benchmarking system might be incorporated within this for the general regulation and betterment of standards.

The majority of the above degrees were delivered by the former Polytechnics, most of which, in turn, became New Universities in the early 1990's or thereabouts. With their conversion to University status came the right to validate and award degrees (previously validated by and awarded under the auspices of the Council for National Academic Awards (CNAA), to whom the former Polytechnics were answerable).

"Up until 1994, the RICS ran its own examinations, but since [then] there has been a progressive change towards qualification through accredited courses at undergraduate and postgraduate level" (RICS, 2008b). This process has recently changed with the introduction of the Assoc. RICS route.

## 5.1.2 Programme Development and the Validation Process

### 5.1.2.1 Programme Development

Any enterprise operating in today's competitive climate should constantly be reviewing potential markets for its products with a view to satisfying these and to long term growth. Academic institutions are no different. And so it is that those responsible for programme development will be on the lookout for appropriate areas of expansion. Provision must keep pace with the times, and adjust where possible to changing professional needs. From this comes the process of the review of existing programmes by programme teams and, from time to time, the creation of new ones. As seen above, this process, known as Validation, is now almost universally one which is internal to the university concerned. Very few, if any, degree courses in surveying are franchised, and even they will be monitored and sanctioned by a "parent" university rather than by the RICS itself.

### 5.1.2.2 Validation

"Validation is the act of academic approval by the university to confirm and verify an award in terms of the appropriate standard for the level of the award and the content as reflected in the award title …" ( Northumbria 2010). Based on one of the Universities studied, the following is an abridged account of the formal Validation requirements and procedures.

Validation will usually not come about except via a panel event, held within the School in question, for and at which all the relevant documentation will be considered. In the case of an undergraduate award the panel make-up will include a subject expert external to the university. In the case of surveying awards such an external expert will usually be a member of the RICS. In addition there will be a Panel Chair and two to four other internal panel members.

#### Documentation must include:

- Programme Specification – a comprehensive document presenting a contextual statement for the new course and covering its operation and composition precisely, including such matters as the delivery and assessment of each module.
- Full descriptive documents "Module Descriptors" will also be submitted for each new module associated with the programme. These last will each contain an outline syllabus, learning objectives, the proposed assessment rationale and a detailed split between class contact, directed learning, private study and assessment.

No Validation will be approved without the full satisfactory presentation of all documents, together with the execution of any corrections or amendments recommended by the School panel. Thus, quality standards across the School can be upheld, and all will be in line with university guidelines.

In the case of a new programme the proposal to develop such materials must be sanctioned by the relevant sub-committee of the University Learning and Teaching Committee. This will take into consideration overall university policies and guidelines regarding funding, resources and long term academic strategies. Only with and after the approval of this Committee can development go ahead at School level.

Stage Two of this process sees the first introduction of detailed proposals, created by course teams – the Programme Specification and other necessary documentation.

### 5.1.3 Interview Analysis

Interview responses all essentially illustrate and support the suggestion that Validation is a process internal to the University, one over which the RICS has no real control. The nearest that they come to having influence is through the external expert, who will tend to be a Chartered Surveyor attached to the discipline to which the programme relates. One interviewee (1) did liken the accreditation process (see Section 5.2, below) to "validation at course level", for here the RICS can have some say over the continuation or otherwise of a course. Another supported this understanding;

*"[RICS] is not directly involved in the validation process within the university but they are part of the process … under the banner of our partnership meetings"* [3].

Two of the interviewees gave lengthy and detailed accounts of the processes operated within their own universities to achieve and maintain certain quality levels across their courses, both much along the lines of the above.

*"There's a standard procedure and whole list of documents actually produced, which evaluating the rationale for this … for the new course, providing [a] resource document obviously, proposing … an overall structure and … content, its curriculum and its modules and maybe writing quite a few new modules if it's quite a new course … one of the things we do in terms of validation is prescribe to a certain format... the university requires us to put together an number of documents … we will have somebody who will be from another university or from practice"* [2].

Both cases served to illustrate that rigour is applied, again as suggested by the example detailed above. Interviewees seemed satisfied in broad terms with the processes concerned, together with the part which they, colleagues and others played in it. Reference was also made to Periodic Reviews.

*"At university level we have … every 5 years we have a review of specific programmes where they come in and there's internal and external people involved in the visiting panel. They'll be coming and look over all the content of the course …"* [1].

These are held by all the Universities (usually on five yearly basis, as suggested), a further check on the maintenance of standards.

One interviewee, remarking in fact on benchmarks and what they ought to cover (but confusing these perhaps with thresholds) suggested that the RICS;

*"should look at how many members of the academic staff are members of the RICS … because if you've got academic membership staff, members of the RICS, they understand the competencies which they feed back into the course developed"* [1].

### 5.1.4 Further Development

The RICS does not have direct influence over the actual award of degrees themselves, lost to it essentially with the granting of degree awarding rights to the New Universities. The degrees, together with the broad outline of their respective validation processes have an ever increasing role to perform. The RICS will have to work through and around the existing structures, exercising such influence as they can through external subject experts, external examiners, academic staff who are members, and the like.

As is suggested above, new developments (or fundamental changes to existing provision) arise out of perceived demand and first see light within a School and/or subject group setting. That is, they are born of academics who are associated with the discipline. These academics will be guided by subject experience, which should include influences from professionals and professional bodies with whom they are in contact. They should also draw on, and be guided by; any documentation produced by the professional body, in this case the RICS, from who they receive accreditation. This last may afford the opportunity for the introduction into the customary documentation the proposed GCTB perhaps as a part of the Programme Specification or as integral part of the set of programme validation documentation.

### 5.1.5 Summary

Validation is, essentially, a private, in-house process, one in which the RICS has no specific involvement and over which it has no direct power. However, there is nothing in university regulations to prevent academics responsible for the design of new programmes/courses, and external subject experts party to the validation process (who in most cases will be themselves be members of the RICS), from heeding and being guided very specifically by benchmarks. Equally, as part of their documentation, universities declare their wish to be guided by good practice from industry. In due course, benchmarks such as those proposed and created as a result of this research may be regarded as embodying good industry practice. In due course the requirement for adherence to such benchmarks may become embedded in the paperwork without which no programme submission will be considered complete.

# 5.2 RICS Programme Accreditation

## 5.2.1 Introduction

Accreditation is closely tied in with, and monitored through, the RICS. The RICS – University Partnership Process, (see Section 5.3, below), as the two are virtually synonymous. Accreditation, once achieved, is reviewed through the media of the Partnership.

## 5.2.2 The Accreditation Process

As noted above, the majority of Quantity Surveying (and others surveying related) degree programmes are now quite long established, and the chief requirement appears to be that these continue to meet certain thresholds through certain specified reporting requirements. These last are tested through the report submitted at the time of the Partnership meeting.

In the case of new programmes seeking accreditation for the first time, or those seeking re-instatement, the requirements are set out in some detail in the document entitled "Policy and guidance on university partnerships" last published in April 2008 (RICS 2008).

The above document stipulates 18 sets of course details that are to be submitted for scrutiny, ranging from general course rationale and philosophy through to support resources. It gives curriculum guidance, but in very generic terms, chiefly through references to APC Mandatory, Core and Optional Competencies. There are no specific syllabi, benchmarks or the like adding further detail or measures to these requirements. Indeed, the document specifically states at one point that the

*"RICS is not prescriptive in terms of course design. It positively welcomes a diversity of provision"* **(RICS 2008b).**

This relatively "light touch" approach deliberately intends to encourage

*"Universities with appropriate expertise, skills and resourcing … to design courses to their particular strengths"* **(RICS 2008b)**

However, it could be suggested that there is a need for greater consistency across curricula, where professionals have shown some dissatisfaction with graduates' ability to exercise Core Skills and others (Perera and Pearson, 2011). Although flexibility to design unique programmes is encouraging, the lack of a minimum benchmark in achieving graduate level competencies removes the ability for the RICS to ensure at least minimum standards are met.

At present, the chief and only precise numerical measure of courses and thus their potential for producing effective surveyors appears to relate to entry qualifications. Here, a specific formula is stated; an average of 270 UCAS points across the top 75% of applicants or a minimum of 230 for any one applicant, a factor which each university may choose for itself. However, in recent communications from the RICS it appears that this threshold in entry criteria is to be removed as well.

## 5.2.3 Interview Analysis

### 5.2.3.1 Accreditation generally

All three interviewees agreed that accreditation is important for their courses. It is a good market selling-point as one of the reasons why students join the course, because they want to be 'RICS' members.

*"I attribute it [success of the course and conversion to membership] to the fact that our students come to our courses with the RICS membership as an objective"* [2].

For this reason it was suggested that accreditation should link course contents more closely to the competencies, but, significantly, we feel, with some consideration of Industry requirements.

*"I think it (accreditation) should be linked to the course content and competencies. But it should also be linked to the input that is coming in from the industry"* [1].

Interviewees were questioned as to the relationship between their approach to course design and assessment in the light of RICS policy and guidance. Nobody considers their own university to be operating in conflict with these.

One interviewee suggested that there must be an appropriate balance between coursework and exams. The interviewee suggested that courses should have more formative assessment than summative assessment. Others agreed;

*"We need to try to have a balance between coursework and exam. So we would have more formative assessment happening throughout the courses leading up to the exam that's happening at the end of the semester. But students are still getting the feedback. They're still getting encouragement of learning and development of knowledge and understanding. But the final assessment happens at the end by an exam"* [3].

This, it is suggested, reflects RICS policy.

### 5.2.3.2 The introduction of benchmarking – in principle

Interviewees were also asked their views, in the context of accreditation, towards the introduction of an exit-related benchmark, the testing of which would form a part of the accreditation and thus the partnership process. Responses were mixed. In one case there was outright support, the only reservation being that courses should still be allowed some scope for specialisation where appropriate.

*"I absolutely support benchmarking … what it is you expect a graduate to do by the end of the course … there should be some set of skills that we should all be aiming for the graduates to do by the end of the year … I think students should have the knowledge of what the core competencies are by the time they leave the university".[1]*

*"Yeah, I think it (benchmark) is useful. I think you have to be clever in what the benchmark is. And it's something that [must be] understood and can be applied by all universities".[3]*

This is, in principle, agreement with the benchmarking. However, there were occasions where more caution expressed over its design and/or implementation.

*"I wouldn't be particularly happy with that .. because I think it goes down the CIOB approach … and APM … I am a bit cautious … because I have a feeling it tends to produce [a] homogenous product. [and they ] end of being very, very similar, which of course is the objective, isn't it in a way?" [2]*

The interviewee previously expressed dissatisfaction over most other institutions adhering to a rigorous regime of quality control. He felt these resulted in more paper work and difficulty in administering programmes.

*"I do have another problem with benchmarking using words. What does that word mean?" We're making benchmark statements. The external examiners have got to confirm that you meet some benchmark. I mean how do you prove that, how do you? … Any benchmark which is essentially based on words is by definition very subjective … and even [in the] external examining process, two examiners might say two different things" [2]*

*"I think it's not right .. the QS have got some indication as part of their APC, a guidance of what to expect of a graduate. The problem is, how do you measure… ?" [3]*

*"The more prescriptive you are, I think there's a danger you become more of an HND than a degree, because of what a degree should really be about." [3]*

The proposed benchmarking system does not make a degree more prescriptive; rather, provides a structure and a system to self-evaluate the level of compliance with RICS competencies. It does not bring a quality of a degree down; on the contrary quality standards are further pushed upwards. The aim is to harmonise the quality of a graduate with industry expectations and standards.

*"… the problem is that if you want benchmarks, you may have to have less competencies. The more competencies you have the less you can be prescriptive … the whole point about that degree is not just teaching. It's about the student developing" [3]*

The level of quality of a degree can be assessed by numerous indicators. Employability of graduates is one key indicator. The proposed GCTB aims to improve employability of graduate by making them more industry relevant and professional.

### 5.2.3.3 The introduction of benchmarking – content / coverage

There was some discussion here, partly in the light of the above, of what topics should or should not be included within the Core Competencies, and, by implication, benchmarks. This was set in the context of the allocation of the overall delivery and assessment time of 3,600 hours, a figure common to most degree programmes though increased in Scottish universities. This reflects the need, as seen by certain academics, for the delivery of certain "basics" without which the students' education to higher levels could not be undertaken or which, at a higher level, were thought an essential part in basic teaching but which did not feature in RICS competency study checklist.

*" … an employer would look at that and expect the graduate to come out and be able to meet the competencies of the RICS".[2]*

*"we've been quite aggressive in making sure that the students understand the context, they understand what they're being taught and how it's covered with the APC." [2]*

*"I think there's a requirement to have core competencies, but those also I think are requirement for the student to understand why they're studying it and why it's relevant to their profession career they've selected." [1]*

Generally it was agreed by interviewees that 70-80% of the 3,600 hours (2520 – 2880 hours) should be dedicated to RICS Competencies. In practice, it appears that the average expenditure of hours on RICS competencies amounts to 3083 hours (85%). See discussion of these figures in section 5.4.1. below.

*"And a lot of it is coming back to knowledge of construction, construction technology of residential and commercial buildings from which there's a greater understanding and building on how you estimate, how you measure. So, I think 70 to 80 is fine." [3]*

Some proportion at least of the 20 or 30% not devoted specifically to RICS Competencies might feature the unique flavour of the specific course. This last, presumably, would have to cover Mandatory Competencies at least.

*"… that 20% or 20 or 30% allows the student or allows the course to give a slightly different flavour. And I think that flavour would depend upon (a) their region. Let's say, for example, us being based in *****. We've got lots of global, commercial firms which we have to provide that sort of client focus, the client understanding. Then that 20 to 30% allows us to give flavour really."* [3]

Such variations from the "norm" as envisaged by the RICS must give rise to negotiations if there is to be acceptance of the benchmarking system. They mirror, in part, certain discrepancies between the RICS Competencies and the core skills of the modern QS as identified by some members of the Expert Forum group.

## 5.2.4 Further Development

It would appear that the existing framework for the design and operation of courses is mostly operating to the satisfaction of the academics. This is partly because there is full freedom for them to decide on curricular content and method of delivery with hardly any imposition from the RICS. Unlike other professional bodies, there is hardly any intervention or requirement by the RICS to bind them to a mechanism of systematic checking. A change, incorporating exit –related benchmarks can only come about through co-operation between the parties. The GCTB is a key component of the CMF which aims to provide a mechanism to systematically incorporate RICS competencies in RICS accredited QS degree programmes. The CMF will only be successful if it comes through the RICS as a mandatory requirement for RICS accredited programmes. The process would involve greater level of cooperation from the academics. In the face of current economic crisis this would be an important change that the RICS and universities need to embrace to make graduates more industry relevant.

## 5.2.5 Summary

Accreditation, it has been shown, is the chief remaining point of control or influence offered to the RICS. Being centrally managed by the Institution it still offers the opportunity for standards or "benchmarks" to be set and to some extent imposed upon programmes at university level.

One of the interviewees in particular expresses concerns lest the benchmarks be too prescriptive, involving the use of wording open to different interpretations by different parties. In practice, the benchmark which we propose is something numerical, a "yardstick" against which the curricula of different courses can be measured. Like all quantitative measures (allowing reasonable margins) this must be less open to misinterpretation than a qualitative write-up of desirable provision.

# 5.3 RICS University Partnership Process

## 5.3.1 Introduction

For those academic institutions currently accredited by the RICS and therefore operating within a Partnership agreement, the continuing Partnership manifests itself through a fairly informal, essentially a "light touch" process. The principal interest and intervention on the part of the RICS is targeted at any proposed new programme or programme development(s) put forward by the member institution.

Reports on student numbers, progression, etc. (addressing "RICS partnership thresholds" – related issues) are submitted, but there is rarely any detailed scrutiny of Module content unless, as suggested above, some change or development is proposed

## 5.3.2 The Partnership Process

The outward form which partnership agreements and monitoring takes is through the annual partnership meeting; for these the agenda is essentially a standard one, as noted by interviewees. Exceptionally there may be a modification relating to issues specific to the institution under scrutiny.

The process is essentially one of on-going review and monitoring. The only specific point of measurement and/or control over programmes, linked directly to their continued accreditation, relates to "threshold standards".

Currently, although these are under review at the time of writing, these are requirements for reporting in three areas;

- Numbers and qualifications of entrants to programmes of study. These should comply with the average or minimum requirements, 270 or 230 UCAS points respectively,
- Numbers of most recent graduates. An earlier requirement regarding their destination has been removed,
- Research activity within the academic department in question, and its relation to delivery and assessment.

It appears that there are no "internal" guidelines held or followed by the RICS team on the Panel. This was stated in a conversation with a key member of the RICS Education Committee and has since been confirmed by one of the current interviewees.

*"I don't think there is anything written down, but we did … have a meeting … and we spent a bit of time … discussing the role of the person involved as a Trustee"* **(1)**

Therefore, the content and structure of any meeting will indeed be much as set out in the above agenda.

## 5.3.3 Interview Analysis

### 5.3.3.1 Process

Generally speaking, interviewees were supportive of the partnership process, as they were partnership meetings.

*"Really, the partnership meeting is the topping of the icing on the cake to make sure we're doing the right thing and everybody is informed."* **(3)**

However, it could be read from this that there is a danger of such a meeting being seen as something of a mere formality, particularly if/when a programme is seen as performing adequately. One respondent, perhaps with something like this in mind, did query the necessity for this to take place on a yearly basis.

*"I think because it happens so regularly, every year … you have to ask, why does it happen every year?"* **(1)**

Others may welcome this face to face contact with the RICS, seen by some as an increasingly distant body (Perera and Pearson, 2011). As one interviewee remarked;

*"I think the further away you are from the source of information, the less you can be influenced or influence that. So, I think the Partnership meeting is a good way of sort of hitting a milestone in a sense".* **(2)**

It was agreed that the agenda was standard one, but it was not felt to be too prescriptive;

*"… in the sense that the agenda for this partnership meeting is jointly produced, then I mean I would imagine that if we had something that we wanted to talk about, we would just put it on the agenda".* **(2)**

It was noted that the Partnership meeting could act not just as a check on process and outcomes but as a spur to the development of new courses and course materials.

*"An example … where the RICS have asked us to be proactive in developing a course"* **(3)**

### 5.3.3.2 Expanding the brief

There was some suggestion that by spending as long time as they did discussing thresholds, in particular those relating to entry, the relatively limited meeting time was not being put to best use;

*"There are other things the RICS could be doing to look at courses and how we link work with curriculum; how we link the co-industry works and how we link with competencies as opposed to spending however many hours it takes to show us [RICS] what entry qualifications your students have got".* **(1)**

*"I think this year they're going to be talking to us about threshold and whether they're going to changing. And we also talk about External Examiner comment report. That's generally what we talk about".* **(2)**

*"… you only see them for 3 or 4 hours. So there's not much you can necessarily develop".* **(3)**

There was some suggestion that links with the local RICS establishment could be stronger and that there might be some overview of these through the Partnership process.

*"… so there's not a lot of discussion happening during that and I think that's a bit of a shame because I think that's where the partnership could actually work quite well between the university and the professional body to get the courses marketed and the events marketed and student networking opportunities, that kind of thing".* **(1)**

*"It's their concrete contribution to this department in terms of providing people, mobilising local RICS resources and that sort of stuff, which would be a useful thing to talk about each-each year to review I think."* **(2)**

*"I think the issue of what the RICS actually does, you know, is an issue which should be more prominent on the agenda".* **(2)**

Interviewees suggested that there must be a different (perhaps better?) format by which to communicate between RICS and Partner University. Two of them suggested moves to improve the communication at local (regional) level. Another interviewee recommended that there should be some RICS representative to talk with students at the induction day, provide more local resources.

But to counter this, one interviewee made the point that they [his university] were pretty good at discussions with the RICS outside the Partnership meetings. Certain academic staff had been, or were, members of Regional or National Committees and the like.

The one interviewee involved with a number of Panel Meetings from an RICS perspective made the point that what is sought of Universities generally is consistency. Referring to National Student Survey (NSS) scores, a factor which is examined at the Partnership meeting;

*"Not the "be all and end all", but … being used to benchmark universities … and the main thing is to have consistency".* **(1)**

## 5.3.4 Further Development

Traditionally, the main thrust of the Partnership process and thus, generally, partnership meetings avoid specific examination of course content or the level of attainment of the student cohort in these, except in exceptional cases where issues have been identified by External Examiners.

As noted elsewhere, the main thrust behind the current research has been the development of a set of benchmarks relating to graduate capabilities. It would seem that this must form a positive compliment to existing thresholds, marking a move away from entry-level scrutiny and approval towards something relating more usefully to actual course content. There are gaps between the perceptions of academia, industry and the Institution as to what should have been and what has been achieved through the education process leading to a first degree in any of the surveying disciplines – we have focussed in specifically on the area of Quantity Surveying (Perera Pearson, 2011). As witnessed by the chief nature of the current "thresholds" referred to above, the RICS has traditionally concentrated on performance measurement from an "entry perspective" (UCAS points) rather than exit – the capacity of the graduate. Benchmarks offer the opportunity to redress the balance.

As seen from the agenda reproduced above, and the observations made by interviewees, the meetings between the RICS and academic institutions are rather formulaic, and may not always respond to specific local needs. A review of local RICS interventions and/or support would seem to be a welcome.

The meeting relies on review of a certain body of paperwork prepared and submitted to the RICS prior to the meeting. It would seem a reasonably easy task for one or more of the course team to complete an annual paper exercise checking course content against the benchmarking document (producing a competency mapping record – CMR). If there is no change in the programme content producing or updating the CMR would not be required. This having been done, any wide discrepancies between the two could be swiftly and easily focussed on at the meeting and appropriate discussion and decision making follow.

## 5.3.5 Summary

The Partnership process, it is suggested, should be refined to take account of a benchmarking exercise, the review of which should be a feature of annual review to produce a programme specific CMR alongside other documentation submitted to the RICS and upon which the latter bases its assessment of the appropriateness, or otherwise, of course provision and standards of attainment. Accreditation, which runs hand in hand with and affords Partner status, should be informed by the outcome of benchmark review and updating.

## 5.4 Discussion

Partnerships between the RICS and those who award its accredited degrees are seen as a good thing in general, although there may be disagreements over the frequency and mechanics of the annual meetings. These last do at least provide a face-to-face forum for the parties chiefly involved, which most welcome.

### 5.4.1 Benchmarking; the ideal

In terms of the measurement of the capabilities of graduates and thus the suitability of the accredited degrees from which they issue, it is perhaps time to move away from an entry-related threshold for potential students to an exit-related threshold for potential members. This could be provided by benchmarking which would afford a certain uniformity of standards. This would remove the large knowledge and understanding gap which seems to exist in the measurement and quality control of the potential professional member, between their first entry onto an Accredited Degree programmes and their arrival for APC assessment some five or six years later.

It seems that if the benchmark (GCTB) is to meet with approval both of the RICS and of academic providers it must avoid wordy passages, open to varying interpretations, being instead a numerical measure of some sort, simple to test against Module content and delivery hours. The GCTB proposed herein, conforms to this ideal in that it is based on RICS competencies, as published for the APC and is a numeric measure with less opportunity for different interpretations.

One possible point for discussion, arising out of interviewees responses, is the actual proportion of the total 3600 hours available (in England) for delivery and assessment of the syllabus which should/ can be tied to benchmarks aimed, as they are, at addressing APC Competencies, at whatever level. At one point there is the suggestion that 70 or 80% of the 3600 hours should suffice for delivery of RICS Competencies, leaving 20 or 30% for everything else. That is, any other subjects not directly related to the latter. One interviewee, confirming this, suggests that the 20 or 30% be devoted to non-Competency related subjects, enabling his or her programme to give flavour. In fact, the current research has shown that the total hours spent on all three Competency-related areas (at whatever level) amounts to 3083 hours average across the universities, or 85%. This suggests that the actual proportion left “spare” in which to “give flavour” should be around 15%, or 540 hours. However, in the final GCTB this spare amount of hours has reduced to 412 hours making an increase in the RICS competency mapped content to 89% of 3600 maximum allowable hours for a degree.

Further consideration of certain Tutors’ expressed wishes, to see a certain percentage of degree content not tied into RICS competencies may suggest a number of considerations;

**Firstly**, there are certain basic skills and understandings referred to there as “related study topics” which, whilst not directly represented by or within RICS competencies, are none the less essential to the preparation of students for those competencies which are so represented.

**Secondly**, as suggested by the RICS itself, may indeed wish to impart some particular specialism, based on an expertise peculiar to a particular institution and/or its staff at any one time, where this may be seen to enrich the employment prospects of the students in one way or another.

**Thirdly**, in defence of academics generally, it is suggested, as discussed in an earlier report (Perera & Pearson, 2011) there may be underlying issues here born of the “Education versus Training” debate. At one level, educators must understand, accept and seek to meet certain demands made on them by the RICS and by Employers. Indeed one of the drivers behind the current research seeks from educators’ recognition of and a compliance with certain contents and standards determined largely by these latter stakeholders. However, it can be argued that it is the educator’s wider duty to act not just as a training organisation for industry but as educators – that is, persons who will teach their students to think and to solve problems outside the fairly strict confines of a particular and specialist set of guidelines. The very fact that, as has been noted elsewhere, the RICS competencies are undergoing review just as this report is being written should perhaps warn against too rigid a regime. Educators must always be allowed some space (in this case within the overall 3600 hour umbrella) in which to impart skills in their students which will equip the latter to operate effectively in a future professional role where any one of the current Core Competencies, for example, no longer has the significance which it has at present.

## 5.4.2 Benchmarks; acceptance and support

Some interviewees expressed some potential resistance to the introduction of benchmarks. As this was a sample group there may be other institutions where this may be the reaction also. As with any system which is to be imposed top-down, so to speak, to prove a successful addition to existing quality systems the new benchmarks (GCTB) should be seen to be an easily operated system, and one that is itself validated by drawing on as wide a cross section of professional perspectives as is practicable. The GCTB produced have certainly achieved this with a wide participation of the representative cross section of the industry. As to ease of use, a numerical grid is proposed, one in which, as regards validation, hopefully this will have been addressed through the use of the professional forum. As to the enthusiasm or otherwise for implementation, this may depend upon how strict the measurement system appears to be, and how much it still allows for universities to express their individual strengths through their programme delivery whilst also meeting new minimum requirements as set by core benchmarks. The practicalities, including this permissible degree of flexibility have still to be determined.

It could be argued that the RICS relinquished a proportion of the automatic say it might otherwise have had over the content and conduct of its related programmes when it removed its requirement, as one of its "threshold standards" that a certain proportion of the staff teaching on a given programme be qualified members of the RICS. Whilst this in itself did not provide a mechanism for dictating Programme content, it seems fair to suggest that staff who were active members of this professional body might have had its interests and standards at heart rather more than those who were not? Such an attachment may make the introduction and management of Benchmarks more easily attainable. This point is specifically referred to by an interviewee reported in section 5.1 above.

On a similar note, it is stated that the

*"RICS no longer approves UK partnership universities' external examiner appointments".* **(RICS, 2011)**

Universities are merely required to inform the Institution of the names of Examiners (commercial and academic); together with any RICS qualifications they hold (if any).

Both of the above relaxations of previous requirements may open the door, it is suggested, to a less stringent enforcement of any benchmarks which are created as a result of current research, unless the RICS can take action to enforce the use of GCTB through RICS – University partnership.

## 6.1 Using for Programme Development

CMF can be used effectively in programme development and validation. It provides a minimum threshold benchmark level of competency required in undergraduate studies in quantity surveying. In the first instance, modules can be designed to directly map either to a single or to multiple competencies. Alternatively, module content can be mapped to competencies using the competency map scoring system incorporating the Depth and Breadth scales described in Section 3 of this report. A sample structure of the GCTB is illustrated in Figure 2.19.

**Figure 2.19** Sample image of the GCTB

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C1.8.7 | Supply chain management | 1 | 1 | | | | |
| C1.8.8 | Legislation on selecting project teams | 1 | 0 | | | | |
| C2 | CORE COMPETENCIES | 136 | 43 | 94.4% | 29.9% | 2060 | 65% |
| C2.1 | Commercial management of construction (T010) – Level 3 | 9 | 5 | 100.0% | 55.6% | 96 | 3.0% |
| C2.1.1 | Estimating | 1 | 1 | | | | |
| C2.1.2 | Establishing budgets | 1 | 1 | | | | |
| C2.1.3 | Cash flows | 1 | 1 | | | | |
| C2.1.4 | Reporting financial progress against budget | 1 | 1 | | | | |
| C2.1.5 | Procurement of labour | 1 | 0 | | | | |
| C2.1.6 | Procurement of plant and materials | 1 | 0 | | | | |
| C2.1.7 | Procurement of sub-contracts | 1 | 1 | | | | |
| C2.1.8 | Financial management of supply chain | 1 | 0 | | | | |
| C2.1.9 | Financial management of multiple projects | 1 | 0 | | | | |
| C2.2 | Contract practice (T017) – Level 3 | 28 | 12 | 100.0% | 42.9% | 243 | 7.6% |
| C2.2.1 | Principles of contract law | 1 | 0 | | | | |
| C2.2.2 | Legislation | 1 | 0 | | | | |
| C2.2.3 | Current case-law – look out for cases reported in journals | 1 | 0 | | | | |

The process of developing module content and ensuring satisfaction of GCTB can be summarised as follows:

1. Identify module topics using the topics list provided in the GCTB.
2. Assign these to relevant modules, in keeping with the overall design of the programme and module structure.
3. Estimate the learning time required for each topic and note these against each topic using the CMT (Appendix B).
4. Summation of the total times spent on each topic in each module will then provide an indication of total times spent on achieving each competency in the CMT.
5. Ensure the Depth scale for each competency in GCTB is achieved.
6. Ensure all topics deemed required in the GCTB Breadth scale is achieved.
7. Record competency mapping for the new programme on the CMT spread sheet.
8. This record serves as the competency mapping record (CMR) for future amendments and modifications to the programme and module content.
9. The CMR can also be included with the programme validation documents as evidence for compliance with RICS competencies.

Module descriptors (specifications) can directly incorporate the study checklist topics or in the case of an existing module descriptor can be mapped against the Graduate competency threshold benchmark (GCTB). In developing a QS degree programme what is important is to ensure all topics deemed essential are incorporated in the module specifications. These are the topics that are marked 1 in the GCTB. The learning outcomes for module specifications therefore should be aligned with competencies in such a way the module content reflects all topics that are deemed essential in the GCTB.

The Depth scale of GCTB indicates the minimum time that is required to be spent on achieving the learning outcomes of modules. Therefore, the estimated time spent on learning module content should achieve or exceed the minimum benchmark values stipulated in GCTB. This is evaluated through estimating the time spent on learning each topic in a module and summing up all values, in keeping with the competency mapping using the CMT.

## 6.2 Using for Programme Management

Existing RICS accredited QS honours degree programmes can be mapped to the CMF. This provides a record of how modules are mapped against RICS competencies. This could then help in further developing the degree programmes and making these more industry relevant. The suggested process of using GCTB for programme management and development is summarised below:

1. Using the CMT map all module content to competencies.
   a. Identify module topics and map these to the Breadth scale in the CMT.
   b. Estimate the amount of learning hours spent on each topic and record them against respective competencies in the Depth scale of the CMT.
   c. Carry out the process for all modules.
2. Upon completion of mapping compare the CMR against the GCTB.
   a. Identify whether there are any uncovered topics.
   b. Identify whether the Depth scales of GCTB are achieved satisfactorily (Note: GCTB is a minimum threshold standard).
3. The programme CMR is a systematically analysed record of how modules map against competencies.
4. Where there are deficiencies in either the Depth or Breadth scales, take action to revise module specifications and/or the degree programme to ensure full compliance with the GCTB.
5. Whenever module revisions or programme revisions take place always update the CMR established for the programme and check against GCTB to ensure compliance with RICS competencies.
6. All programme revisions should be reported to the RICS partnership meetings supplemented with a CMR for the programme.

# 7.0 Conclusions

## 7.1 The need and the research approach

Over the years QS education has evolved from being rather technical in nature to fully fledged honours degrees with greater proportion of construction and project management orientation. The transition from diplomas to university degrees was in cognition with the general transformation of the higher education sector of the British education system. Subsequently the construction industry has undergone many changes and is currently facing a double dip economic recession causing a severe impact on opportunities for graduate employment within the sector. Construction industry employers have been vocal in identifying their perception of a lowering employability of graduates. A recent study investigating views on both industry and academia concluded that there are significant levels of dissatisfaction on quality of graduate (Perera & Pearson, 2011). It identified the root cause of the issue as graduates produced by different RICS accredited degree programmes have significantly different competency levels often far below what the industry expects.

A competency mapping framework (CMF) was proposed as a solution for achieving competencies at or above a minimum threshold benchmark. This research developed the CMF with a graduate competency threshold benchmark (GCTB) that uses the RICS competencies structure developed for the QS pathway to membership.

The research utilised a four stage research method using current RICS QS competencies along with the collaboration of industry and academic experts (refer section 2 for full details). The four stages were:

**Stage 1** – Pilot Study
A literature review of competencies and developing a competency mapping template (CMT). It used two industry and academic experts to iteratively develop and modify the CMT. The CMT is a dual vector scale matrix with a Breadth scale and a Depth scale each mapped against module descriptors. Breadth scale contains study topics while Depth scale contains competencies (refer Appendix B).

**Stage 2** – Case Studies
Four leading RICS accredited QS degree programmes were analysed and the module specifications were mapped to competencies using the CMT. This created a CMR for each case study. Descriptive statistical analysis was used to develop a conceptual competency benchmark using these four case studies.

**Stage 3** – Expert Forum
An expert forum with 12 industry experts and 3 academic experts were established to revise and modify the conceptual competency benchmark. The two stage Delphi process was used to record and harmonise views of experts. This stage produced the final graduate competency threshold benchmark (GCTB).

**Stage 4** – Review of Existing Processes to Integrate CMF
The final stage of the research involved reviewing existing programme development validation method, RICS programme accreditation and RICS – University partnership processes. This involved a document review as well as interviews of three QS degree programme directors to obtain their views on these processes and the GCTB. The report presents how the CMF can be used within these existing systems to ensure academic quality standards.

## 7.2 The Competency Mapping Framework (CMF)

The core element of the CMF is the GCTB which is a minimum level benchmark for mapping curricula to RICS competencies. This is produced in a MS Excel™ spreadsheet (Refer Appendix A). The GCTB contains a Breadth scale and a Depth scale (see Figure 19).

The Breadth scale is the checklist of topics categorised according to competencies. This is based on the RICS APC study checklist (RICS, 2008). It provides an indication of which topics need to be covered at competency levels 1 and 2. It should be noted that Level 3 competency achievement is not considered as the GCTB is a minimum threshold. Further, at graduate level it is unlikely that any competency could be achieved at Level 3 to a satisfactory degree. Each study topic contains a unique reference code.

The Depth scale provides the number of learning hours that should be spent at undergraduate level to attain respective competency. As module specifications of degree programmes specify learning hours as credits (where 1 credit = 10 hours of learning) the Depth scale provides a harmonious way to measure the learning requirements.

The summary statistics of the GCTB is presented in Table 2.6.

Analysing the Breadth scale it is clear that there are a total of 305 topics to be covered representing 85% of total topics at Level 1. As one would expect, this comes down to 102 topics (28%) at Level 2. Core competencies have 94% coverage of topics at Level 1 reducing to 30% at Level 2. This indicates that in the case of core competencies, there is foundation level knowledge expected rather than expertise in its application. However, the highest coverage at Level 2 is for Mandatory competencies (41%). This is mainly because those Mandatory competencies represent generic skills and as such are expected to be covered to a higher degree of competence at graduate level.

A comparison of the effect of changes proposed in the GCTB is presented in Table 2.7. This compares the GCTB with the mean values extracted from the four case studies of RICS accredited QS degree programmes (refer section 3.3 for details).

Analysing the Depth scale, there are a total of 3188 hours of learning time expected on RICS competencies. This is of possible 3600 hours representing 89% of time. This is much higher than current provision of most RICS accredited programmes (85%). As expected, 65% of the time is expected to be spent on Core competencies which accounts for 57% full credit allocation for a degree programme. This is an increase in emphasis from the current provision (53%). This represents a reasonable content considering the specialist nature of the profession. This is then followed by Optional and Mandatory competencies respectively.

Another notable change from the existing provision is the consequent reduction in time allocation with respect to learning related to Non RICS competencies. There is a 3% reduction in time. These learning primarily represent generic study areas such as basic economics, law, mathematical skills etc. However, one could argue as these underpin direct RICS competency related topics the shift could be minimal and depends on interpretation of mapping. It is for this reason that future revisions to competencies and the study checklist should consider the inclusion of such topics at Level 1.

The amount of time to be spent on any one topic is difficult to precisely stipulate as well as it may make the GCTB too prescriptive. The uniqueness of individual degree programmes will therefore be defined on the lines of variations in the extent and level of coverage of topics. The GCTB therefore, facilitates adequate provision for innovation in individual degree programmes while ensuring minimum levels of satisfaction of RICS competencies.

**Table 2.6** Summary statistics of GCTB

| Competency Type | | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 Topics | Level 2 Topics | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| C1 | Mandatory Competencies | 66 | 31 | 88% | 41% | 521 | 16% |
| C2 | Core Competencies | 136 | 43 | 94% | 30% | 2060 | 65% |
| C3 | Optional Competencies | 103 | 28 | 74% | 20% | 607 | 19% |
| Totals | | 305 | 102 | 85% | 28% | 3188 | 100.0% |

**Table 2.7** Comparison of proposed competency time allocations (GCTB)

| Competency Type | | Proposed on GCTB | | Existing Composition (Case Studies) | |
|---|---|---|---|---|---|
| | | Credit hours | % Percentage | Credit hours | % Percentage |
| C1 | Mandatory Competencies | 521 | 15% | 557 | 16% |
| C2 | Core Competencies | 2060 | 57% | 1899 | 53% |
| C3 | Optional Competencies | 607 | 17% | 628 | 17% |
| C4 | Non RICS Competencies | 412 | 11% | 517 | 14% |
| Totals | | 3600 | 100% | 3600 | 100% |

## 7.3 Recommended use of the CMF

It is envisaged that CMF can be used primarily in two ways:

1. For the development of new degree programmes and validation
2. For monitoring and management of existing degree programmes.

These options are discussed in detail in section 6. When new programmes are developed, the GCTB can be used to identify module content for module descriptors. It is suggested that the CMT to be used to initially map topics of module descriptors (specifications) to RICS competencies. The systematic approach presented in the CMF helps in this process to ensure that competency levels exceed minimum requirements. Upon completion of the CMT the resultant CMR forms an authentic record of how module descriptors are mapped to RICS competencies.

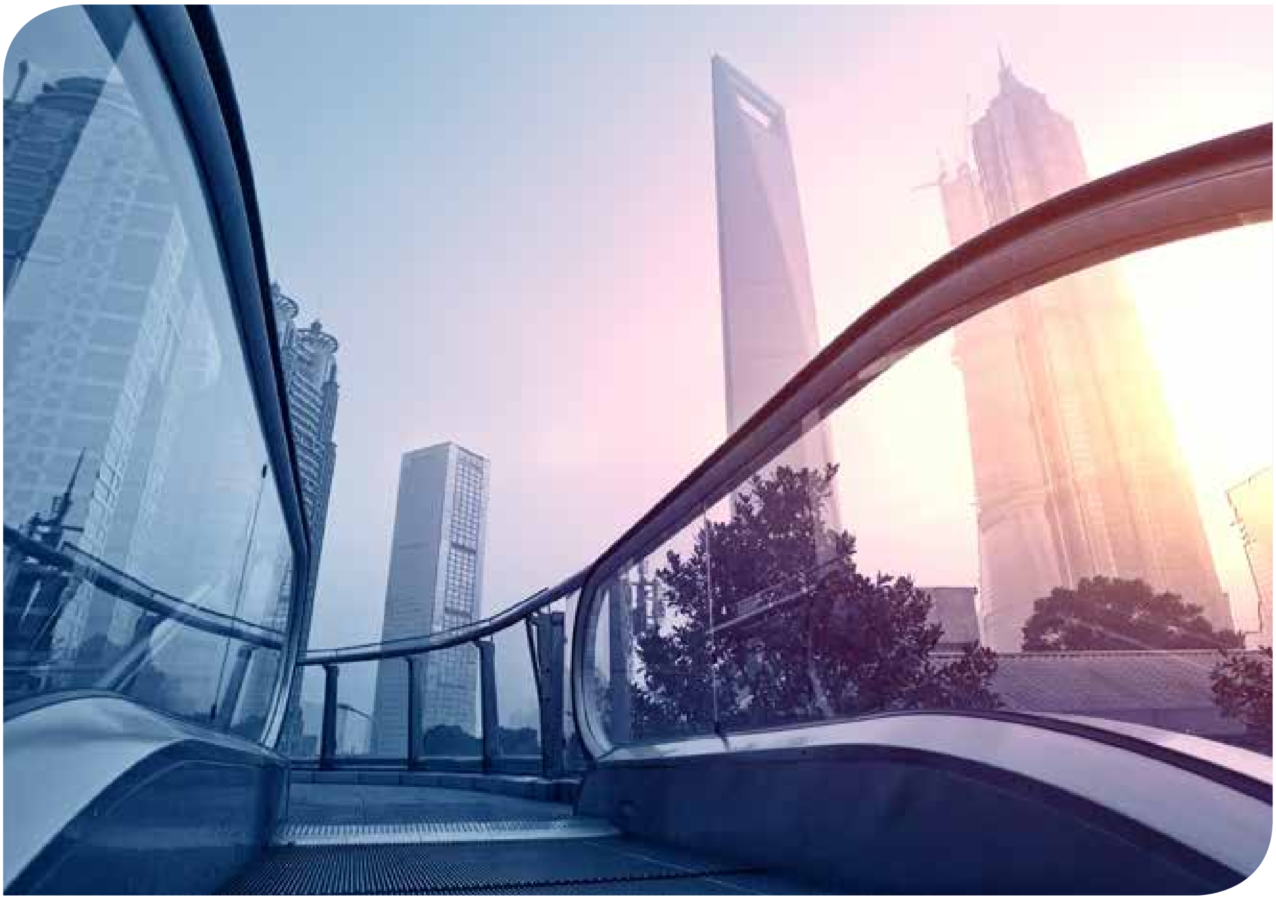
The GCTB can be used to evaluate existing RICS accredited degree programmes. When a CMR for a RICS accredited degree programme is created it forms a formal record of how degree programme content maps to RICS competencies. This can then be evaluated against the GCTB to identify whether degree programmes fully comply with the minimum thresholds identified in the GCTB. Where benchmarks are not achieved programmes can be modified to comply with GCTB. In a similar way the CMR for the programme should be updated whenever programme modifications or module modifications are carried out. It can then be checked against the GCTB to check compliance.

## 7.4 Final Recommendations

This report introduces CMF as a system for maintaining and improving quality and professional standards of QS degree programmes accredited by the RICS. The following are the primary recommendations of the report.

- It is recommended that the CMF be made an essential part of the RICS – University partnership agreement. This way it provides a mechanism to ensure that all RICS accredited programmes meet the exit threshold defined by the GCTB. Each RICS accredited programme should complete a CMR which then can be updated and presented to the RICS – University partnership meeting annually with any changes made being highlighted.
- CMF should be used for ensuring achievement of competencies in all new QS degree programmes to be accredited by the RICS. It should form part of programme validation and accreditation documents (where RICS accreditation is sought).
- In the case of all new programmes seeking RICS accreditation, completion of the CMR should be mandatory, to ensure it meets GCTB thresholds.
- The CMF also provides a useful process for the programme external examiners. They can be entrusted to comment on the changes to programmes evaluated against the GCTB thereby ensuring compliance.
- The GCTB recommends only 84% of study topic-related competencies at Level 1. It is suggested that innovative programmes should aim at achieving the remaining over and above the minimum benchmark recommended.

The GCTB developed and presented herein is based on current RICS competencies (RICS, 2009) and APC study Checklist documentation (RICS, 2008 a). It is recommended that whenever competency structures change the GCTB should be updated accordingly.



## 7.5 Limitations

The GCTB created was based on existing set of RICS competencies and the APC study checklist of topics produced by the RICS. It was noted that this checklist had many limitations. There were many related study topics that were missing from the list. This indicates that it may not be up to date or fully reflect current practice. There is some repetition of topics, appearing on different competencies. Some topic descriptors were not clear as to the meaning or content.

Added to this one should perhaps recognise and accommodate the general duty of educators to prepare their students in the broadest sense, and not merely in respect of certain specified skills areas i.e. provide "education".

The expert forum for the development of GCTB was limited to 15 industry and academic experts. A higher number would have achieved greater representation of views. However, in the selection of the expert forum care was exercised to achieve a good distribution of expertise from consulting to contracting, from practice based to academic and a distribution of different organisation sizes reflecting micro, SME and large organisations.

## 7.6 Further Research

It is proposed that further research should be undertaken to further develop the study check list to make it reflect the work profile of the modern QS as accurately as possible. This should attempt at re-classification of some of the study topics, using better descriptors for topics.

The same problem can be extrapolated to the situation where new entrants to RICS come through the Assoc RICS route. Those seeking Associate membership must pass the ATC for which they will be eligible upon successful completion of a Foundation Degree or equivalent, together with a specified period of approved work experience. A similar benchmark for such programmes the RICS seek to recognise will eliminate such problems of dissatisfaction and subjective interpretation of competencies as have been discussed above.

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**Srinath Perera and John Pearson**
August 2013

# Part 3
# References and Appendix

Note: Appendices B & C indicated in this report and additional information is available at
**www.northumbria-qs.org/index.php/completed-projects/cmf**

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Appendix B & C: available at http://www.northumbria-qs.org/index.php/completed-projects/cmf.

Appendix A

# Final Graduate Competency Threshold Benchmark (GCTB)

**Level 1** – Knowledge and understanding
**Level 2** – Application of knowledge and understanding
**Level 3** – Reasoned advice and depth of technical knowledge

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C1 | MANDATORY COMPETENCIES | 66 | 31 | 88% | 41.3% | 521 | 16% |
| C1.1 | Accounting principles and procedures (M001) – Level 1 | 8 | 0 | 80.0% | 0.0% | 10 | 0.3% |
| C1.1.1 | Balance sheets / profit and loss account | 1 | 0 | | | | |
| C1.1.2 | Taxation | 1 | 0 | | | | |
| C1.1.3 | Revenue and capital expenditure | 1 | 0 | | | | |
| C1.1.4 | Cash flows | 1 | 0 | | | | |
| C1.1.5 | Auditing | 1 | 0 | | | | |
| C1.1.6 | Ratio analysis | 0 | 0 | | | | |
| C1.1.7 | Credit control | 0 | 0 | | | | |
| C1.1.8 | Profitability | 1 | 0 | | | | |
| C1.1.9 | Insolvency | 1 | 0 | | | | |
| C1.1.10 | Legislation | 1 | 0 | | | | |
| C1.2 | Business planning (M002) – Level 1 | 6 | 0 | 100.0% | 0.0% | 24 | 0.8% |
| C1.2.1 | Legislation | 1 | 0 | | | | |
| C1.2.2 | Short / long term strategies | 1 | 0 | | | | |
| C1.2.3 | Market analysis | 1 | 0 | | | | |
| C1.2.4 | Five year plans | 1 | 0 | | | | |
| C1.2.5 | Business support services – administration, secretarial, HR, IT etc. | 1 | 0 | | | | |
| C1.2.6 | Staffing levels – recruitment / turnover | 1 | 0 | | | | |
| C1.3 | Client care (M003) – Level 2 | 6 | 4 | 75.0% | 50.0% | 36 | 1.1% |
| C1.3.1 | Understanding client objectives | 1 | 1 | | | | |
| C1.3.2 | Establishing client's brief | 1 | 1 | | | | |
| C1.3.3 | Appointment documents | 0 | 0 | | | | |
| C1.3.4 | Fees | 1 | 0 | | | | |
| C1.3.5 | Complaints procedures | 0 | 0 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C1.3.6 | Key Performance Indicators | 1 | 0 | | | | |
| C1.3.7 | Establishing communications with client team | 1 | 1 | | | | |
| C1.3.8 | Involvement of stakeholders | 1 | 1 | | | | |
| C1.4 | Communication and negotiation (M004) – Level 2 | 16 | 14 | 100.0% | 87.5% | 138 | 4.3% |
| | Oral communication: | | | | | | |
| C1.4.1 | Phone calls | 1 | 1 | | | | |
| C1.4.2 | Reporting at meetings | 1 | 1 | | | | |
| C1.4.3 | Facilitating/chairing meeting | 1 | 1 | | | | |
| C1.4.4 | Client and bid presentations | 1 | 1 | | | | |
| C1.4.5 | Staff presentations | 1 | 1 | | | | |
| C1.4.6 | Contractor/consultant interviews | 1 | 1 | | | | |
| C1.4.7 | Public speaking at seminars etc | 1 | 1 | | | | |
| C1.4.8 | Listening skills | 1 | 1 | | | | |
| | Written/graphical communication: | | | | | | |
| C1.4.9 | Letters, memos and emails | 1 | 1 | | | | |
| | Report writing: | | | | | | |
| C1.4.10 | Programming | 1 | 1 | | | | |
| C1.4.11 | Using drawn information – checking scales and revisions | 1 | 1 | | | | |
| C1.4.12 | Using CAD documents | 1 | 1 | | | | |
| | Negotiation: | | | | | | |
| C1.4.13 | Establishing objectives | 1 | 0 | | | | |
| C1.4.14 | Setting strategy | 1 | 1 | | | | |
| C1.4.15 | Collecting and presenting evidence | 1 | 1 | | | | |
| C1.4.16 | Confirmation of agreement | 1 | 0 | | | | |
| C1.5 | Conduct rules, ethics and professional practice (M005) – Level 3 | 9 | 2 | 64.3% | 14.3% | 26 | 0.8% |
| C1.5.1 | RICS Rules of Conduct | 1 | 1 | | | | |
| C1.5.2 | Conduct befitting a chartered surveyor | 1 | 1 | | | | |
| C1.5.3 | Registration of firms | 0 | 0 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C1.5.4 | Complaints procedure | 0 | 0 | | | | |
| C1.5.5 | Conflicts of interest | 1 | 0 | | | | |
| C1.5.6 | Gifts | 1 | 0 | | | | |
| C1.5.7 | Professional Indemnity Insurance | 1 | 0 | | | | |
| C1.5.8 | Client accounts | 0 | 0 | | | | |
| C1.5.9 | Regulation | 1 | 0 | | | | |
| C1.5.10 | Disciplinary procedures | 1 | 0 | | | | |
| C1.5.11 | Lifelong learning – CPD | 1 | 0 | | | | |
| C1.5.12 | Current RICS structure | 0 | 0 | | | | |
| C1.5.13 | Faculties | 0 | 0 | | | | |
| C1.5.14 | Current RICS issues and initiatives | 1 | 0 | | | | |
| C1.6 | Data management (M007) – Level 1 | 7 | 5 | 100.0% | 71.4% | 82 | 2.6% |
| C1.6.1 | BCIS / BMI or other external sources | 1 | 1 | | | | |
| C1.6.2 | Elemental analyses | 1 | 1 | | | | |
| C1.6.3 | Pricing books | 1 | 1 | | | | |
| C1.6.4 | Data base use generally | 1 | 1 | | | | |
| C1.6.5 | Employer's in-house data storage and filing systems | 1 | 0 | | | | |
| C1.6.6 | Scheduling | 1 | 1 | | | | |
| C1.6.7 | Libraries | 1 | 0 | | | | |
| C1.7 | Health and safety (M008) – Level 2 | 6 | 0 | 100.0% | 0.0% | 72 | 2.3% |
| | Personal health and safety at work – RICS publication 'Surveying Safely' Personal safety procedures when visiting a construction site Common health and safety risks in construction Health and safety legislation: | | | | | | |
| C1.7.1 | Generally | 1 | 0 | | | | |
| C1.7.2 | At work | 1 | 0 | | | | |
| C1.7.3 | Construction specific | 1 | 0 | | | | |
| C1.7.4 | Sector specific | 1 | 0 | | | | |
| C1.7.5 | Client specific | 1 | 0 | | | | |
| C1.7.6 | Asbestos and other hazardous materials | 1 | 0 | | | | |
| C1.8 | Teamworking (M010) – Level 1 | 8 | 6 | 100.0% | 75.0% | 133 | 4.2% |
| C1.8.1 | Understand the role of team members | 1 | 1 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C1.8.2 | Appointing the project team | 1 | 1 | | | | |
| C1.8.3 | Relationships with other team members | 1 | 1 | | | | |
| C1.8.4 | Communicating with other team members | 1 | 1 | | | | |
| C1.8.5 | Partnering and collaborative working | 1 | 1 | | | | |
| C1.8.6 | Strategic alliance | 1 | 0 | | | | |
| C1.8.7 | Supply chain management | 1 | 1 | | | | |
| C1.8.8 | Legislation on selecting project teams | 1 | 0 | | | | |
| C2 | CORE COMPETENCIES | 136 | 43 | 94.4% | 29.9% | 2060 | 65% |
| C2.1 | Commercial management of construction (T010) – Level 3 | 9 | 5 | 100.0% | 55.6% | 96 | 3.0% |
| C2.1.1 | Estimating | 1 | 1 | | | | |
| C2.1.2 | Establishing budgets | 1 | 1 | | | | |
| C2.1.3 | Cash flows | 1 | 1 | | | | |
| C2.1.4 | Reporting financial progress against budget | 1 | 1 | | | | |
| C2.1.5 | Procurement of labour | 1 | 0 | | | | |
| C2.1.6 | Procurement of plant and materials | 1 | 0 | | | | |
| C2.1.7 | Procurement of sub-contracts | 1 | 1 | | | | |
| C2.1.8 | Financial management of supply chain | 1 | 0 | | | | |
| C2.1.9 | Financial management of multiple projects | 1 | 0 | | | | |
| C2.2 | Contract practice (T017) – Level 3 | 28 | 12 | 100.0% | 42.9% | 243 | 7.6% |
| C2.2.1 | Principles of contract law | 1 | 0 | | | | |
| C2.2.2 | Legislation | 1 | 0 | | | | |
| C2.2.3 | Current case-law – look out for cases reported in journals | 1 | 0 | | | | |
| C2.2.4 | Standard forms of main and sub contract – e.g. JCT, NEC/ECC, GC Works, ICE, ACA, IChemE, FIDIC, etc. | 1 | 1 | | | | |
| C2.2.5 | Roles & responsibilities of parties – Client, Contract Administrator / Employer's Agent / Project manager / Engineer, Contractor, Sub-contractors, Quantity Surveyor | 1 | 1 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C2.2.6 | Assignment / Novation | 1 | 0 | | | | |
| C2.2.7 | Third party rights – Legislation / Collateral Warranties | 1 | 0 | | | | |
| C2.2.8 | Letters of intent – Comfort letters / Consent to spend / Recognition of contract | 1 | 0 | | | | |
| C2.2.9 | Performance security – Bonds / Parent Company Guarantees | 1 | 0 | | | | |
| C2.2.10 | Insurances | 1 | 0 | | | | |
| C2.2.11 | Advance payments | 1 | 0 | | | | |
| C2.2.12 | Interim valuations and payment provisions | 1 | 1 | | | | |
| C2.2.13 | Materials on/off site | 1 | 1 | | | | |
| C2.2.14 | Fluctuations | 1 | 1 | | | | |
| C2.2.15 | Retention – retention bonds | 1 | 1 | | | | |
| C2.2.16 | Change procedures | 1 | 1 | | | | |
| C2.2.17 | Valuing change – variations / compensation events | 1 | 1 | | | | |
| C2.2.18 | Extensions of time | 1 | 1 | | | | |
| C2.2.19 | Claims / Loss and Expense | 1 | 1 | | | | |
| C2.2.20 | Dispute avoidance and resolution | 1 | 0 | | | | |
| C2.2.21 | Named / Nominated subcontractors | 1 | 0 | | | | |
| C2.2.22 | Sectional Completion / Partial Possession | 1 | 0 | | | | |
| C2.2.23 | Design Portions / Performance specified works | 1 | 0 | | | | |
| C2.2.24 | Determination | 1 | 0 | | | | |
| C2.2.25 | Final Accounts | 1 | 1 | | | | |
| C2.2.26 | Completion | 1 | 0 | | | | |
| C2.2.27 | Liquidated and Ascertained Damages | 1 | 0 | | | | |
| C2.2.28 | Defects rectification period | 1 | 1 | | | | |
| C2.3 | Construction technology and environmental services (T013) – Level 3 | 30 | 0 | 85.7% | 0.0% | 660 | 20.7% |
| | Construction technology | | | | | | |
| C2.3.1 | Substructures – basements, types of piling, etc. | 1 | 0 | | | | |
| C2.3.2 | Superstructures | 1 | 0 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C2.3.3 | Comparison of concrete / steel frames | 1 | 0 | | | | |
| C2.3.4 | Floor structures | 1 | 0 | | | | |
| C2.3.5 | External walls, windows and doors | 1 | 0 | | | | |
| C2.3.6 | Cladding / glazing | 1 | 0 | | | | |
| C2.3.7 | Roof structures and coverings | 1 | 0 | | | | |
| C2.3.8 | Partitioning systems and doors | 1 | 0 | | | | |
| C2.3.9 | Finishes and fixtures | 1 | 0 | | | | |
| C2.3.10 | Hard and soft landscaping | 0 | 0 | | | | |
| | Engineering structures | | | | | | |
| C2.3.11 | Bridges | 1 | 0 | | | | |
| C2.3.12 | Tunnels | 1 | 0 | | | | |
| C2.3.13 | Roads | 1 | 0 | | | | |
| C2.3.14 | Railways | 0 | 0 | | | | |
| C2.3.15 | Waterways | 1 | 0 | | | | |
| C2.3.16 | Sea defences | 1 | 0 | | | | |
| C2.3.17 | Earthworks | 1 | 0 | | | | |
| C2.3.18 | Sewage treatment plants | 1 | 0 | | | | |
| C2.3.19 | Processing plant | 0 | 0 | | | | |
| | Services technology | | | | | | |
| C2.3.20 | Electrical systems | 1 | 0 | | | | |
| C2.3.21 | Mechanical systems | 1 | 0 | | | | |
| C2.3.22 | Internal / external drainage | 1 | 0 | | | | |
| C2.3.23 | Mains services | 1 | 0 | | | | |
| C2.3.24 | Air-conditioning / ventilation systems | 1 | 0 | | | | |
| C2.3.25 | Fire safety systems | 1 | 0 | | | | |
| C2.3.26 | Security systems | 1 | 0 | | | | |
| C2.3.27 | Environmental systems and controls | 1 | 0 | | | | |
| C2.3.28 | Data systems | 1 | 0 | | | | |
| C2.3.29 | Building types and other structures | 1 | 0 | | | | |
| C2.3.30 | Building regulations and codes | 1 | 0 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C2.3.31 | Planning legislation and procedures | 0 | 0 | | | | |
| C2.3.32 | Party wall issues / rights of light | 0 | 0 | | | | |
| C2.3.33 | Dangerous / banned substances – asbestos etc | 1 | 0 | | | | |
| C2.3.34 | Pre-fabrication | 1 | 0 | | | | |
| C2.3.35 | Disability legislation | 1 | 0 | | | | |
| C2.4 | Design economics and cost planning (T022) – Level 3 | 15 | 11 | 100.0% | 73.3% | 275 | 8.6% |
| C2.4.1 | Economics of design –site density, wall / floor ratio, storey heights, room sizes, letable / non-letable | 1 | 1 | | | | |
| C2.4.2 | Sources of cost data – BCIS / in-house database / other external sources | 1 | 1 | | | | |
| C2.4.3 | Inflation (tender / construction) | 1 | 1 | | | | |
| C2.4.4 | Location factors, regional variations | 1 | 1 | | | | |
| C2.4.5 | Currency fluctuations | 1 | 0 | | | | |
| C2.4.6 | Estimating | 1 | 1 | | | | |
| C2.4.7 | Cost Plans | 1 | 1 | | | | |
| C2.4.8 | Cost Planning | 1 | 1 | | | | |
| C2.4.9 | Life cycle costing – capital / running costs / replacement | 1 | 1 | | | | |
| C2.4.10 | Value Engineering | 1 | 1 | | | | |
| C2.4.11 | Value Management | 1 | 1 | | | | |
| C2.4.12 | Risk Management and Analysis (contingency) | 1 | 1 | | | | |
| C2.4.13 | State of the construction market | 1 | 0 | | | | |
| C2.4.14 | State of the economy generally – locally and globally | 1 | 0 | | | | |
| C2.4.15 | Interest rates | 1 | 0 | | | | |
| C2.5 | Procurement and tendering (T062) – Level 3 | 24 | 4 | 92.3% | 15.4% | 203 | 6.4% |
| | Types of procurement: | | | | | | |
| C2.5.1 | Traditional | 1 | 1 | | | | |
| C2.5.2 | Design and Build | 1 | 1 | | | | |
| C2.5.3 | Management Contracting | 1 | 0 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C2.5.4 | Construction Management | 1 | 0 | | | | |
| C2.5.5 | Measured Term | 1 | 0 | | | | |
| C2.5.6 | Serial contracting | 0 | 0 | | | | |
| | Financial basis: | | | | | | |
| C2.5.7 | Lump sum | 1 | 0 | | | | |
| C2.5.8 | Re-measured | 1 | 0 | | | | |
| C2.5.9 | Reimbursable | 1 | 0 | | | | |
| C2.5.10 | Target cost | 1 | 0 | | | | |
| C2.5.11 | Guaranteed or Agreed Maximum Price | 1 | 0 | | | | |
| | Tendering: | | | | | | |
| C2.5.12 | Standard rules of tendering – codes of practice, practice notes | 1 | 0 | | | | |
| C2.5.13 | Single / two-stage tendering – competitive / negotiated | 1 | 0 | | | | |
| C2.5.14 | Compilation of tender lists – pre-qualifying contractors | 1 | 0 | | | | |
| C2.5.15 | Compilation of tender documents | 1 | 0 | | | | |
| C2.5.16 | Tender analysis | 1 | 0 | | | | |
| C2.5.17 | Tender reports | 1 | 0 | | | | |
| C2.5.18 | Partnering – project and strategic | 1 | 0 | | | | |
| C2.5.19 | Private Finance Initiative – PFI | 1 | 0 | | | | |
| C2.5.20 | Public Private Partnership – PPP | 1 | 0 | | | | |
| C2.5.21 | Prime contracting | 0 | 0 | | | | |
| C2.5.22 | Best Value | 1 | 1 | | | | |
| C2.5.23 | Whole life costing | 1 | 1 | | | | |
| C2.5.24 | Supply Chain Management | 1 | 0 | | | | |
| C2.5.25 | Lean Construction | 1 | 0 | | | | |
| C2.5.26 | Key Performance Indicators – KPI | 1 | 0 | | | | |
| C2.6 | Project financial control and reporting (T067) – Level 3 | 10 | 3 | 100.0% | 30.0% | 121 | 3.8% |
| C2.6.1 | Post contract cost control | 1 | 1 | | | | |
| C2.6.2 | Change control procedures | 1 | 0 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C2.6.3 | Change control forms | 1 | 0 | | | | |
| C2.6.4 | Cost reporting | 1 | 1 | | | | |
| C2.6.5 | Final accounts | 1 | 1 | | | | |
| C2.6.6 | Loss and expense | 1 | 0 | | | | |
| C2.6.7 | Risk management | 1 | 0 | | | | |
| C2.6.8 | Cash flows | 1 | 0 | | | | |
| C2.6.9 | Value engineering | 1 | 0 | | | | |
| C2.6.10 | Benchmarking / Best value | 1 | 0 | | | | |
| C2.7 | Quantification and costing of construction works (T074) – Level 3 | 20 | 8 | 95.2% | 38.1% | 462 | 14.5% |
| | Methods of measurement: | | | | | | |
| C2.7.1 | SMM / CESMM | 1 | 1 | | | | |
| C2.7.2 | RICS Code of Measuring Practice | 1 | 0 | | | | |
| | Preparation of pricing documents: | | | | | | |
| C2.7.3 | Tender documents generally | 1 | 1 | | | | |
| C2.7.4 | Bill of quantity | 1 | 1 | | | | |
| C2.7.5 | Schedule of works | 1 | 1 | | | | |
| C2.7.6 | Schedule of rates | 1 | 1 | | | | |
| C2.7.7 | Provisional Sums / Prime Cost Sums | 1 | 1 | | | | |
| | Analysis of price: | | | | | | |
| C2.7.8 | Tender returns | 1 | 0 | | | | |
| C2.7.9 | Guaranteed / Agreed Maximum Price | 0 | 0 | | | | |
| C2.7.10 | Target cost – Pain / Gain mechanisms | 1 | 0 | | | | |
| C2.7.11 | Loss and expense | 1 | 0 | | | | |
| C2.7.12 | Preliminaries | 1 | 0 | | | | |
| C2.7.13 | Dayworks | 1 | 0 | | | | |
| | Valuation of works: | | | | | | |
| C2.7.14 | Interim valuations | 1 | 1 | | | | |
| C2.7.15 | Valuing change | 1 | 0 | | | | |
| C2.7.16 | Loss and expense | 1 | 0 | | | | |
| C2.7.17 | Final account | 1 | 0 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C2.7.18 | Reporting on cost | 1 | 1 | | | | |
| C2.7.19 | Tender report | 1 | 0 | | | | |
| C2.7.20 | Correcting errors in tenders | 1 | 0 | | | | |
| C2.7.21 | Post contract financial reporting | 1 | 0 | | | | |
| C3 | OPTIONAL COMPETENCIES | 103 | 28 | 73.6% | 20.0% | 607 | 19% |
| C3.1 | Capital allowances (T008) | 7 | 0 | 58.3% | 0.0% | 11 | 0.4% |
| C3.1.1 | Current legislation | 1 | 0 | | | | |
| C3.1.2 | Capital and revenue expenditure | 1 | 0 | | | | |
| C3.1.3 | Taxation | 1 | 0 | | | | |
| C3.1.4 | Capital Allowances legislation | 1 | 0 | | | | |
| C3.1.5 | Claiming capital allowances | 1 | 0 | | | | |
| C3.1.6 | Plant and machinery | 1 | 0 | | | | |
| C3.1.7 | Industrial buildings | 0 | 0 | | | | |
| C3.1.8 | Hotels | 0 | 0 | | | | |
| C3.1.9 | Research and development | 1 | 0 | | | | |
| C3.1.10 | Enterprise zones | 0 | 0 | | | | |
| C3.1.11 | First year allowances | 0 | 0 | | | | |
| C3.1.12 | Enhanced capital allowances | 0 | 0 | | | | |
| C3.1 | Capital allowances (T008) | 7 | 0 | 58.3% | 0.0% | 11 | 0.4% |
| C3.2.1 | How standard forms of contract deal with conflict avoidance and dispute resolution | 1 | 0 | | | | |
| C3.2.2 | Conflict avoidance | 1 | 0 | | | | |
| C3.2.3 | Partnering | 1 | 0 | | | | |
| C3.2.4 | Negotiation | 1 | 0 | | | | |
| C3.2.5 | Mediation | 1 | 0 | | | | |
| C3.2.6 | Conciliation | 1 | 0 | | | | |
| C3.2.7 | Adjudication | 1 | 0 | | | | |
| C3.2.8 | Arbitration | 1 | 0 | | | | |
| C3.2.9 | Pre-action Protocol | 1 | 0 | | | | |
| C3.2.10 | Litigation | 1 | 0 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C3.2.11 | Expert Witness | 1 | 0 | | | | |
| C3.2.12 | Independent Expert Determination | 1 | 0 | | | | |
| C3.3 | Contract administration (T016) | 21 | 2 | 95.5% | 9.1% | 81 | 2.5% |
| C3.3.1 | Standard forms of Contract – JCT, GC Works, ICE, NEC/ ECC, ACA (PPC2000) etc | 1 | 1 | | | | |
| C3.3.2 | Roles and responsibilities of parties -client, contractors, designers, Q.S | 1 | 1 | | | | |
| C3.3.3 | Role and responsibilities of person administering the contract – e.g. CA, Architect, EA, PM, Engineer etc. | 1 | 0 | | | | |
| C3.3.4 | Co-ordination of parties | 1 | 0 | | | | |
| C3.3.5 | Design co-ordination | 1 | 0 | | | | |
| C3.3.6 | Planning and building regulatory controls | 1 | 0 | | | | |
| C3.3.7 | Health & Safety – CDM | 1 | 0 | | | | |
| C3.3.8 | Monitoring progress | 1 | 0 | | | | |
| C3.3.9 | Monitoring quality | 0 | 0 | | | | |
| C3.3.10 | Insurances | 1 | 0 | | | | |
| C3.3.11 | Bonds / Parent Company Guarantees | 1 | 0 | | | | |
| C3.3.12 | Third party rights | 1 | 0 | | | | |
| C3.3.13 | Payment provisions | 1 | 0 | | | | |
| C3.3.14 | Change procedures | 1 | 0 | | | | |
| C3.3.15 | Sectional Completion / Partial Possession | 1 | 0 | | | | |
| C3.3.16 | Nominated / Named Subcontractors | 1 | 0 | | | | |
| C3.3.17 | Extensions of time / loss and expense | 1 | 0 | | | | |
| C3.3.18 | Materials on / off site | 1 | 0 | | | | |
| C3.3.19 | Determination | 1 | 0 | | | | |
| C3.3.20 | Liquidated and ascertained damages | 1 | 0 | | | | |
| C3.3.21 | Completion | 1 | 0 | | | | |
| C3.3.22 | Defects / rectification period | 1 | 0 | | | | |
| C3.4 | Corporate recovery and insolvency (T020) | 2 | 0 | 15.4% | 0.0% | 10 | 0.3% |
| C3.4.1 | Types of Insolvency | 1 | 0 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C3.4.2 | Bankruptcy | 0 | 0 | | | | |
| C3.4.3 | Individual voluntary arrangement | 0 | 0 | | | | |
| C3.4.4 | Liquidation | 0 | 0 | | | | |
| C3.4.5 | Administrative receivership / Fixed charge receivership | 0 | 0 | | | | |
| C3.4.6 | Company voluntary arrangement | 0 | 0 | | | | |
| C3.4.7 | Role of the QS if insolvency occurs | 1 | 0 | | | | |
| C3.4.8 | Termination and suspension of contracts | 0 | 0 | | | | |
| C3.4.9 | Assignment / novation | 0 | 0 | | | | |
| C3.4.10 | Ownership of material and plant | 0 | 0 | | | | |
| C3.4.11 | Bonds and guarantees | 0 | 0 | | | | |
| C3.4.12 | Set-off | 0 | 0 | | | | |
| C3.4.13 | RICS Information Paper on Construction Insolvency | 0 | 0 | | | | |
| C3.5 | Due Diligence (T025) | 3 | 0 | 20.0% | 0.0% | 6 | 0.2% |
| C3.5.1 | Project monitoring on management style contracts | 0 | 0 | | | | |
| C3.5.2 | Fund monitoring | 0 | 0 | | | | |
| C3.5.3 | Feasibility study | 0 | 0 | | | | |
| C3.5.4 | Planning and building regulatory control | 0 | 0 | | | | |
| C3.5.5 | Suitability of team | 1 | 0 | | | | |
| C3.5.6 | Suitability of procurement route | 1 | 0 | | | | |
| C3.5.7 | Tendering | 0 | 0 | | | | |
| C3.5.8 | Contractual arrangements | 0 | 0 | | | | |
| C3.5.9 | Third party rights | 0 | 0 | | | | |
| C3.5.10 | Suitability of programme | 0 | 0 | | | | |
| C3.5.11 | Cash flows | 0 | 0 | | | | |
| C3.5.12 | Interim payments | 0 | 0 | | | | |
| C3.5.13 | Draw-down | 0 | 0 | | | | |
| C3.5.14 | Final accounts | 0 | 0 | | | | |
| C3.5.15 | Risk | 1 | 0 | | | | |
| C3.6 | Insurance (T045) | 6 | 0 | 50.0% | 0.0% | 13 | 0.4% |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C3.6.1 | Professional Indemnity Insurance | 1 | 0 | | | | |
| | Generally and RICS requirements: | | | | | | |
| C3.6.2 | Indemnifying the employer | 1 | 0 | | | | |
| C3.6.3 | Third-party liability – persons and property | 1 | 0 | | | | |
| C3.6.4 | Insurance of the works – joint names | 1 | 0 | | | | |
| C3.6.5 | Subrogation | 1 | 0 | | | | |
| C3.6.6 | Non-negligence insurance | 0 | 0 | | | | |
| C3.6.7 | Setting level of cover | 0 | 0 | | | | |
| C3.6.8 | In the aggregate / each and every event | 0 | 0 | | | | |
| C3.6.9 | Excess | 0 | 0 | | | | |
| C3.6.10 | Net contribution clause | 0 | 0 | | | | |
| C3.6.11 | Performance bonds | 1 | 0 | | | | |
| C3.6.12 | Fire insurance valuations | 0 | 0 | | | | |
| C3.7 | Programming and planning (T063) | 16 | 8 | 100.0% | 50.0% | 97 | 3.0% |
| C3.7.1 | Project programming | 1 | 1 | | | | |
| C3.7.2 | Multi-project programming | 1 | 0 | | | | |
| C3.7.3 | Flow diagrams | 1 | 1 | | | | |
| C3.7.4 | Activity schedules | 1 | 1 | | | | |
| C3.7.5 | Gant charts | 1 | 1 | | | | |
| C3.7.6 | Critical path | 1 | 1 | | | | |
| C3.7.7 | Key milestones | 1 | 1 | | | | |
| C3.7.8 | Float | 1 | 1 | | | | |
| C3.7.9 | Cash flows | 1 | 1 | | | | |
| C3.7.10 | Progress monitoring | 1 | 0 | | | | |
| C3.7.11 | Project handbook | 1 | 0 | | | | |
| C3.7.12 | Project Execution Plans – PEP | 1 | 0 | | | | |
| C3.7.13 | Establishing team | 1 | 0 | | | | |
| C3.7.14 | Roles and responsibilities | 1 | 0 | | | | |
| C3.7.15 | Commissioning / handover procedure | 1 | 0 | | | | |
| C3.7.16 | Close-out reports | 1 | 0 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C3.8 | Project evaluation (T066) | 13 | 10 | 100.0% | 76.9% | 118 | 3.7% |
| C3.8.1 | Appraisal methods | 1 | 1 | | | | |
| C3.8.2 | Residual value | 1 | 1 | | | | |
| C3.8.3 | Value / income | 1 | 1 | | | | |
| C3.8.4 | Valuation of property / rental values | 1 | 0 | | | | |
| C3.8.5 | RICS Red Book | 1 | 0 | | | | |
| C3.8.6 | Costs | 1 | 1 | | | | |
| C3.8.7 | Land acquisition | 1 | 0 | | | | |
| C3.8.8 | Construction costs | 1 | 1 | | | | |
| C3.8.9 | Fees | 1 | 1 | | | | |
| C3.8.10 | Finance costs | 1 | 1 | | | | |
| C3.8.11 | Taxation, grants, capital allowances | 1 | 1 | | | | |
| C3.8.12 | Profitability | 1 | 1 | | | | |
| C3.8.13 | Planning | 1 | 1 | | | | |
| C3.9 | Risk management (T077) | 11 | 7 | 84.6% | 53.8% | 58 | 1.8% |
| C3.9.1 | Workshops | 1 | 1 | | | | |
| C3.9.2 | Identification | 1 | 1 | | | | |
| C3.9.3 | Register | 1 | 1 | | | | |
| C3.9.4 | Management plan | 1 | 1 | | | | |
| C3.9.5 | Mitigation | 1 | 0 | | | | |
| C3.9.6 | QS contribution to risk management | 1 | 1 | | | | |
| C3.9.7 | Risk analysis | 1 | 1 | | | | |
| C3.9.8 | Probability and impact | 1 | 1 | | | | |
| C3.9.9 | Expected Monetary Value – EMV | 1 | 0 | | | | |
| C3.9.10 | Monte Carlo Simulation | 1 | 0 | | | | |
| C3.9.11 | Central Limit Theory – CLT | 0 | 0 | | | | |
| C3.9.12 | Route Mean Square – RMS | 0 | 0 | | | | |
| C3.9.13 | Contingency | 1 | 0 | | | | |
| C3.10 | Sustainability (M009) | 12 | 1 | 100.0% | 8.3% | 144 | 4.5% |
| C3.10.1 | Sustainable development / construction | 1 | 1 | | | | |
| C3.10.2 | National and international regulations | 1 | 0 | | | | |

| Code | RICS QS Study Check List Topics | Breadth Scale | | | | Depth Scale | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | Level 2 | % Topic Coverage Level 1 | % Topic Coverage Level 2 | Credit hours | % Percentage |
| | | 305 | 102 | 85% | 28% | 3188 | 100.0% |
| C3.10.3 | Environmental assessment methods – e.g. LEED, BREEAM etc. | 1 | 0 | | | | |
| C3.10.4 | Building Regulations and Codes | 1 | 0 | | | | |
| C3.10.5 | Contaminated land | 1 | 0 | | | | |
| C3.10.6 | Waste management | 1 | 0 | | | | |
| C3.10.7 | Recyclable materials | 1 | 0 | | | | |
| C3.10.8 | Sustainable materials | 1 | 0 | | | | |
| C3.10.9 | Building environmental management systems | 1 | 0 | | | | |
| C3.10.10 | Water conservation | 1 | 0 | | | | |
| C3.10.11 | Energy generation | 1 | 0 | | | | |
| C3.10.12 | Energy conservation | 1 | 0 | | | | |
| Total Topics = 359 | | 305 | 102 | 85% | 28% | 3188 | 100% |

**Level 1** – Knowledge and understanding

**Level 2** – Application of knowledge and understanding

**Level 3** – Reasoned advice and depth of technical knowledge

**RICS HQ**
Parliament Square
London SW1P 3AD
United Kingdom

**Worldwide media enquiries:**
**e** pressoffice@rics.org

**Contact Centre:**
**e** contactrics@rics.org
**t** +44 (0)24 7686 8555
**f** +44 (0)20 7334 3811

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RICS has a worldwide network. For further information simply contact the relevant RICS office or our Contact Centre.

**Europe (excluding United Kingdom and Ireland)**
Rue Ducale 67
1000 Brussels
Belgium
**t** +32 2 733 10 19
**f** +32 2 742 97 48
ricseurope@rics.org

**Asia**
Room 2203
Hopewell Centre
183 Queen's Road East
Wanchai
Hong Kong
**t** +852 2537 7117
**f** +852 2537 2756
ricsasia@rics.org

**Americas**
One Grand Central Place
60 East 42nd Street
Suite 2810
New York 10165 – 2810
USA
**t** +1 212 847 7400
**f** +1 212 682 1295
ricsamericas@rics.org

**United Kingdom**
Parliament Square
London SW1P 3AD
United Kingdom
**t** +44 (0)24 7686 8555
**f** +44 (0)20 7334 3811
contactrics@rics.org

**Africa**
PO Box 3400
Witkoppen 2068
South Africa
**t** +27 11 467 2857
**f** +27 86 514 0655
ricsafrica@rics.org

**Ireland**
38 Merrion Square
Dublin 2
Ireland
**t** +353 1 644 5500
**f** +353 1 661 1797
ricsireland@rics.org

**Oceania**
Suite 2, Level 16
1 Castlereagh Street
Sydney, NSW 2000
Australia
**t** +61 2 9216 2333
**f** +61 2 9232 5591
info@rics.org.au

**Middle East**
Office G14, Block 3
Knowledge Village
Dubai
United Arab Emirates
**t** +971 4 375 3074
**f** +971 4 427 2498
ricsmenea@rics.org

**India**
48 & 49 Centrum Plaza
Sector Road
Sector 53, Gurgaon – 122002
India
**t** +91 124 459 5400
**f** +91 124 459 5402
ricsindia@rics.org

SEPTEMBER 2013/DML/18500/RESEARCH


Quantity Surveying Seminar Number 9

# Analysis of the Delegate Survey

## How to educate quantity surveyors to meet future needs

Professor Srinath Perera
Dr Lei Zhou
Damilola Ekundayo
Construction Economics & Management Research Group www.northumbria-qs.org
Northumbria University

Professor Allan Ashworth
Barry Symonds
CHOBE Executive

northumbria UNIVERSITY

# Part 1: Respondent Profile

The survey was conducted among the participants of the CHOBE QS seminar IX held at Birmingham City University on 29 November 2012.
There were primarily 3 types of respondents: academics, students and industry practitioners. A total of 21 responses were received and their types and experience profile are indicated in respectively.

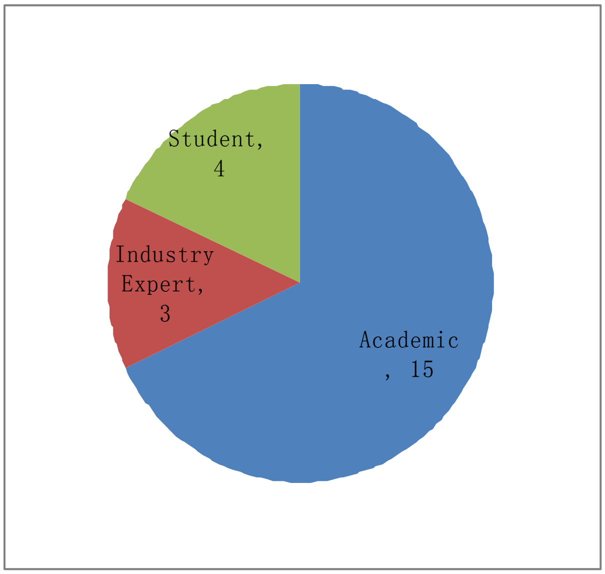



Figure 1 Type of respondents

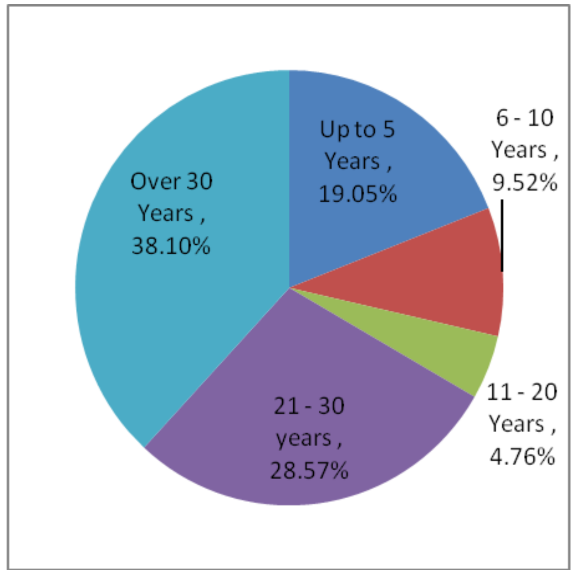



Figure 2 Respondent experience profile

# Part 2: General

Please choose the appropriate response for each item based on your perspective of what should be included in QS graduate education and/or expected of a QS graduate

1. Should professional bodies decide the content of the curriculum if accreditation is required?

| | Yes | Uncertain | No |
|---|---|---|---|
| QS Undergraduate study | ☐ | ☐ | ☐ |
| QS Postgraduate study | ☐ | ☐ | ☐ |

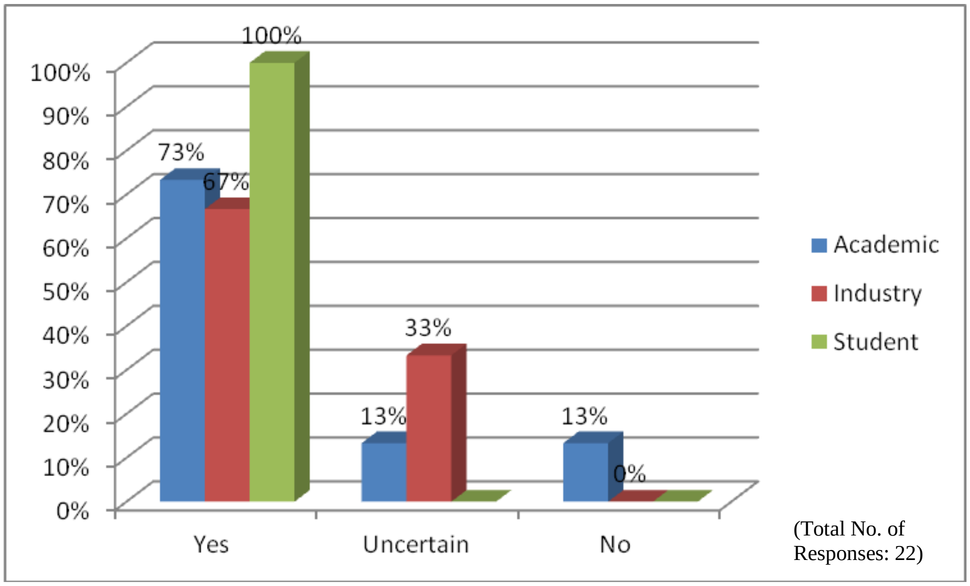



Figure 3 Views on whether the Professional Body should decide on the undergraduate programme curricular

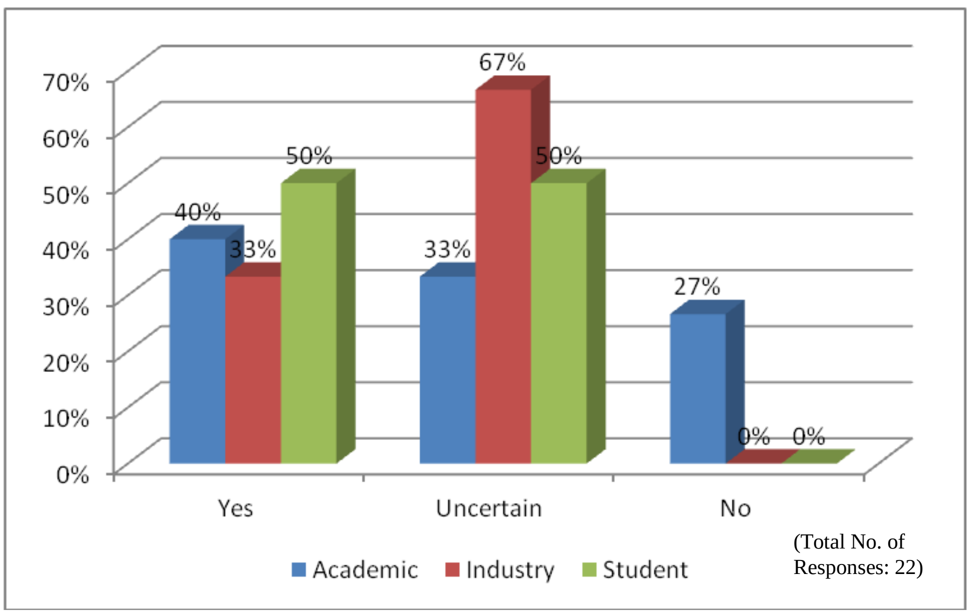



Figure 4 Views on whether the Professional Body should decide on the postgraduate programme curricular

2. Should universities focus more on education rather than training?

| | Yes | Uncertain | No |
|---|---|---|---|
| QS Undergraduate study | ☐ | ☐ | ☐ |
| QS Postgraduate study | ☐ | ☐ | ☐ |

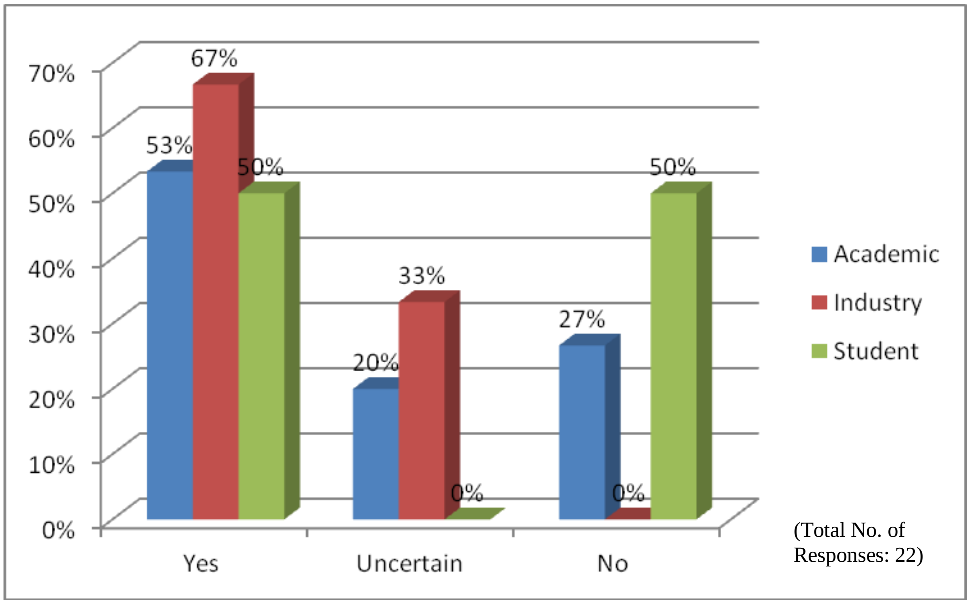



Figure 5 Views on whether focus should be on Education or Training at undergraduate level

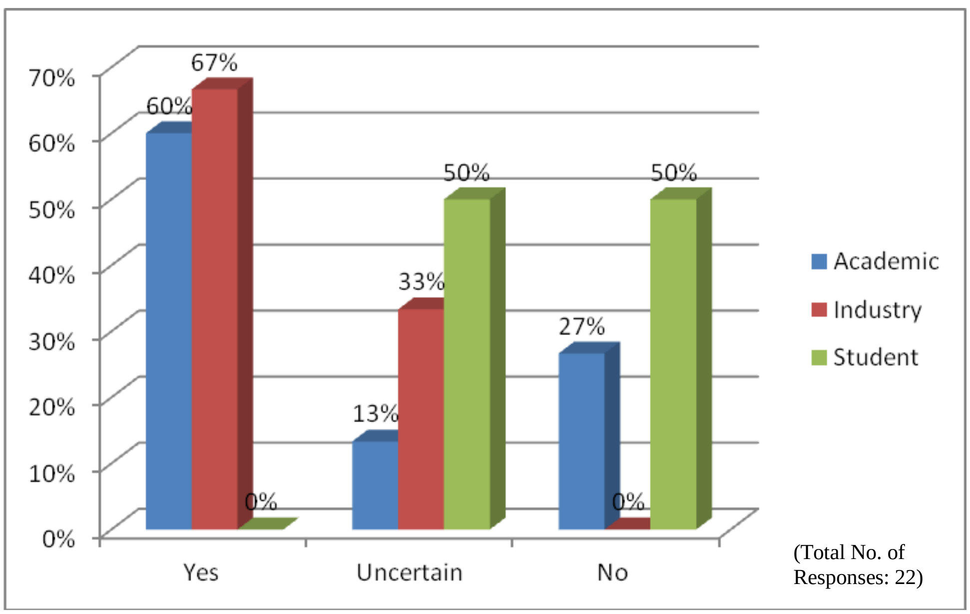



Figure 6 Views on whether focus should be on Education or Training at postgraduate level

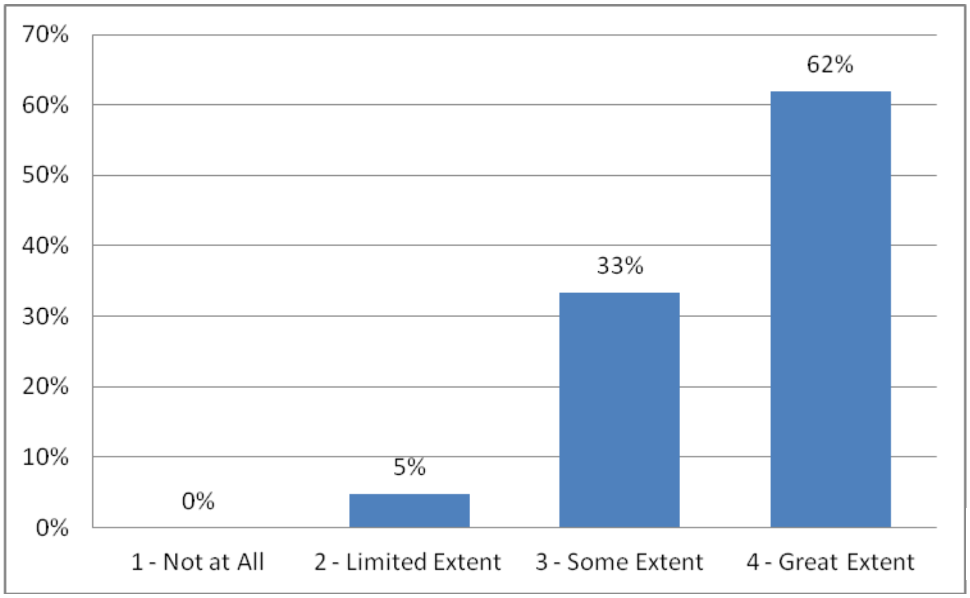
3. Please indicate the extent to which QS programmes should include technical content?

QS Undergraduate study

- ☐ 1: Not at All
- ☐ 2: Limited Extent
- ☐ 3: Some Extent
- ☐ 4: Great Extent

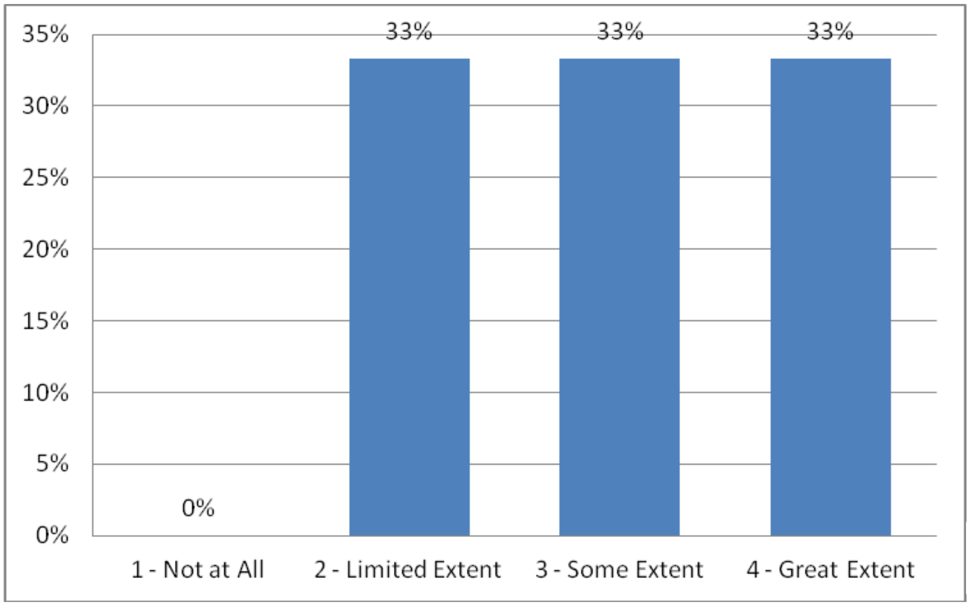
QS Postgraduate study

- ☐ 1: Not at All
- ☐ 2: Limited Extent
- ☐ 3: Some Extent
- ☐ 4: Great Extent




(Total No. of Responses: 21)

Figure 7 Views on whether QS programmes should include technical content (Undergraduate)




(Total No. of Responses: 21)

Figure 8 Views on whether QS programmes should include technical content (Postgraduate)

4. Should QS Undergraduate study include a mandatory placement module?

Yes ☐ Uncertain ☐ No ☐

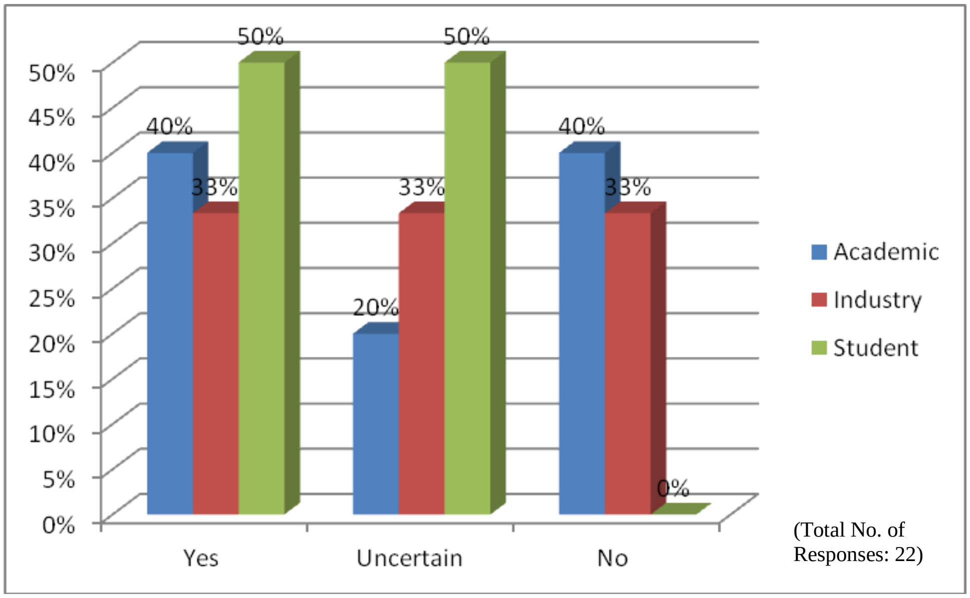



Figure 9 Views on whether placement should be compulsory

5. Should a QS master's programme be about (Please choose only one answer):

☐ Learning advance technology and techniques applicable to industry
☐ Developing and advancing theoretical knowledge and understanding
☐ Advancing technical ability in a specific area

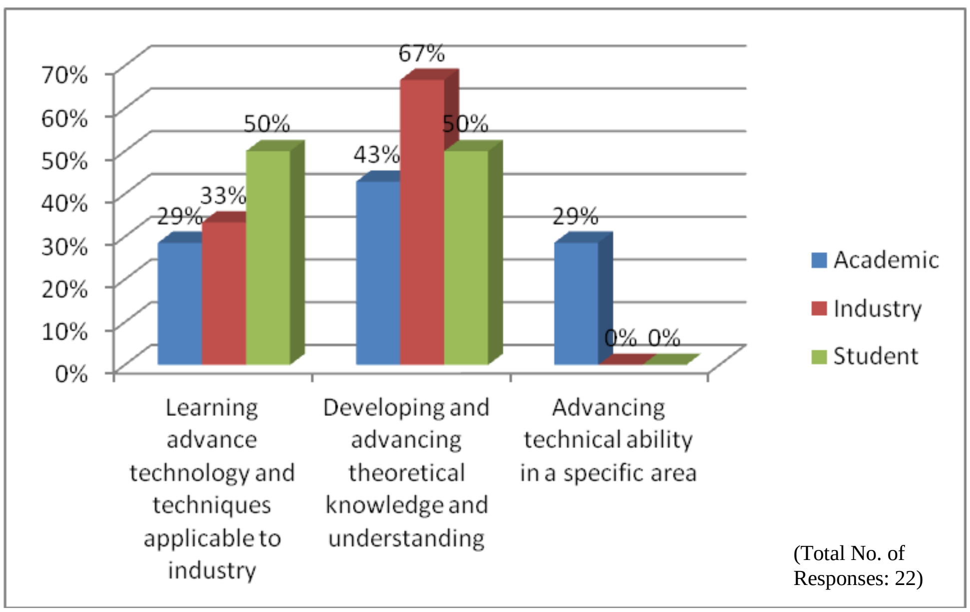



Figure 10 Nature of QS master's programmes

6. Do non cognate QS master programmes produce good quantity surveyors?

Yes ☐ Uncertain ☐ No ☐

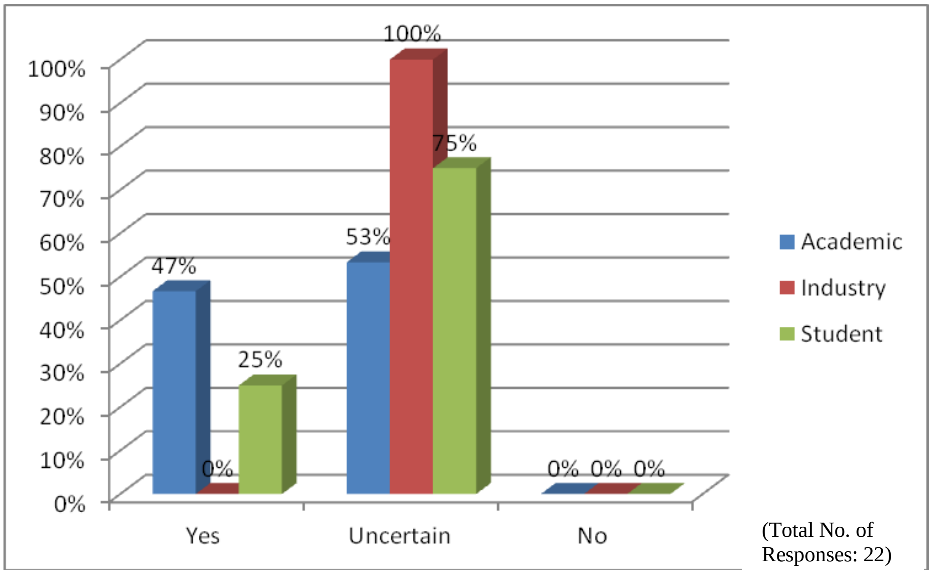



Figure 11 Views on whether non cognate QS master programmes produce good Quantity surveyors

7. How important is it that all QS staff teaching on programmes have continuous or periodic practical involvement in the construction industry?

☐ 1: Unimportant ☐ 2: Of Little Importance ☐ 3: Moderately Important ☐ 4: Very Important

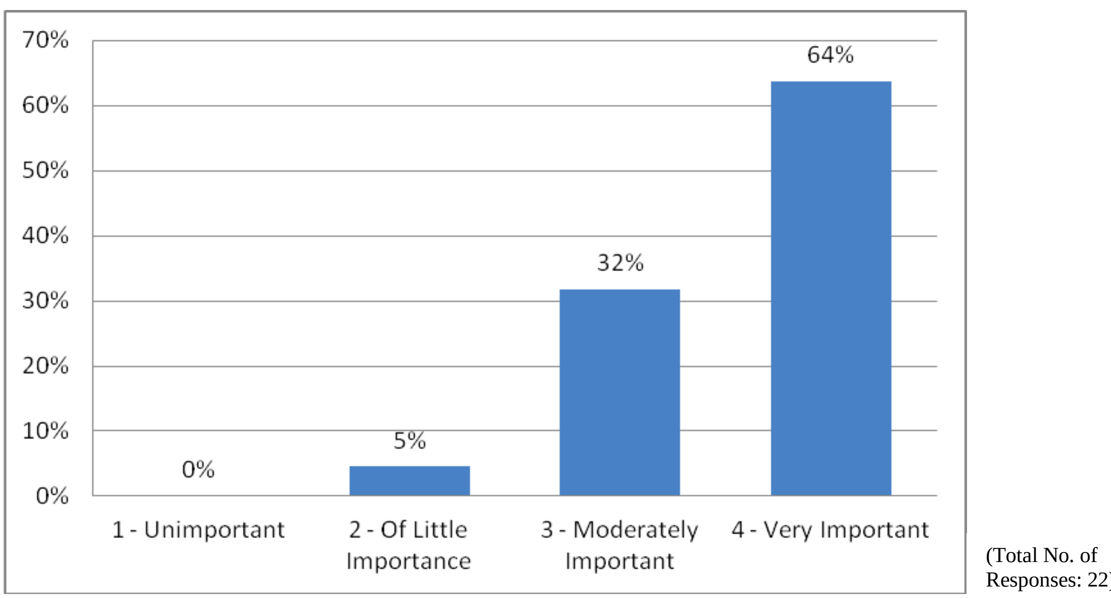
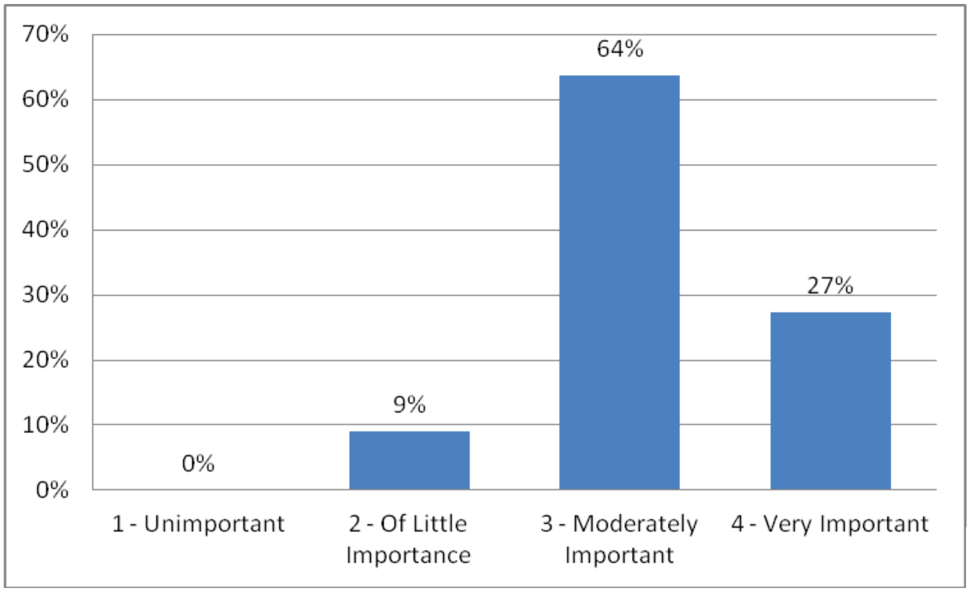



Figure 12 Importance of continuous or periodic practical involvement in the construction industry

8. How important is it for staff teaching on QS programmes to be involved in ongoing research?

☐ 1: Unimportant ☐ 2: Of Little Importance ☐ 3: Moderately Important ☐ 4: Very Important

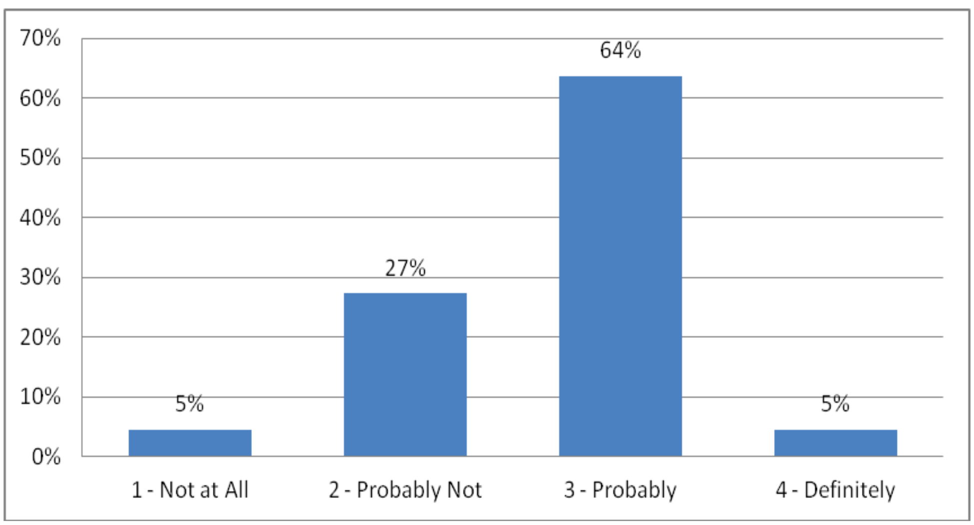



(Total No. of Responses: 22)

Figure 13 Importance of involvement in research

9. If there is a shortage of research-active QS staff, is there a danger that QS programmes could be relegated to teaching only technical universities in the future?

☐ 1: Not at All ☐ 2: Probably Not ☐ 3: Probably ☐ 4: Definitely




(Total No. of Responses: 22)

Figure 14 Level of probability that QS programmes could be relegated to teaching only technical universities in the future

# Part 3: RICS New Rules of Measurement (NRM)

NRM 1: Order of cost estimating and cost planning for capital building works
NRM 2: Detailed measurement for building works - an alternative to SMM7
NRM 3: Order of cost estimating and cost planning for building maintenance works

1. Indicate your level of awareness of the following three NRM documents?

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| NRM 1 | ☐ | ☐ | ☐ | ☐ |
| NRM 2 | ☐ | ☐ | ☐ | ☐ |
| NRM 3 | ☐ | ☐ | ☐ | ☐ |

(1- Not at all aware; 2- Slightly aware; 3- Moderately aware; 4- Extremely aware)

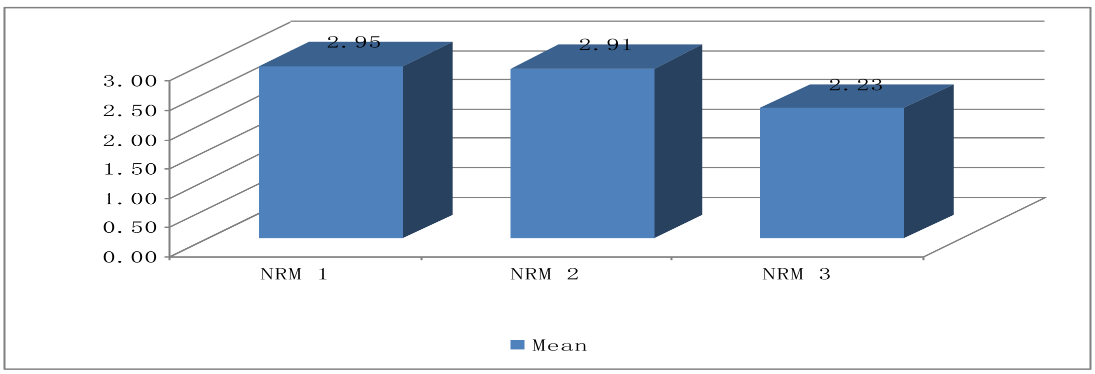



Figure 15 Awareness of the three NRM documents

2. How important is the NRM suite of documents in a world that has become more global?

(Total No. of Responses: 22)

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| NRM 1 | ☐ | ☐ | ☐ | ☐ |
| NRM 2 | ☐ | ☐ | ☐ | ☐ |
| NRM 3 | ☐ | ☐ | ☐ | ☐ |

(1- Not at all important; 2- Slightly important; 3- Moderately important; 4- Extremely important)

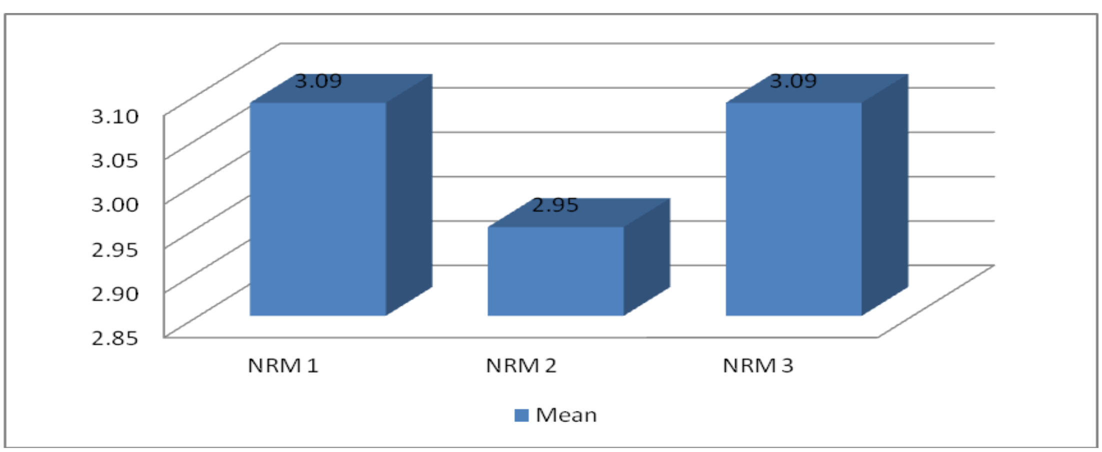



Figure 16 Importance of NRM suite of documents

(Total No. of Responses: 22)

3. How confident are you in the level of knowledge you have in the following (published NRM documents):

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| NRM 1 | ☐ | ☐ | ☐ | ☐ |
| NRM 2 | ☐ | ☐ | ☐ | ☐ |

(1- Not at all confident; 2- Partially confident; 3- Reasonably confident; 4- Fully confident)

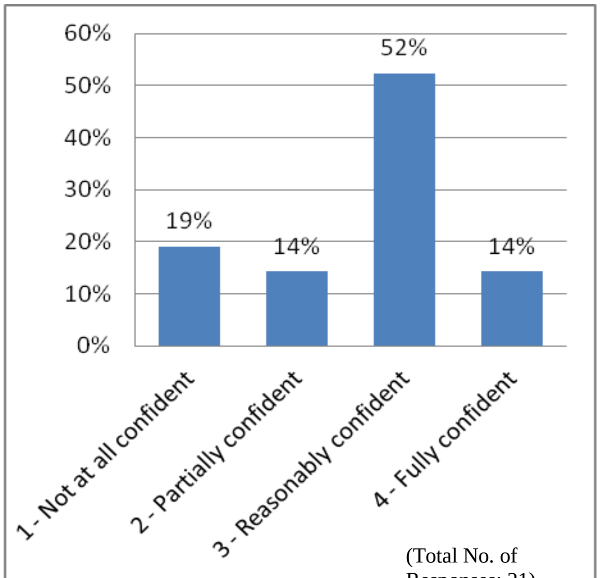



Figure 17 Confidence level of NRM 1

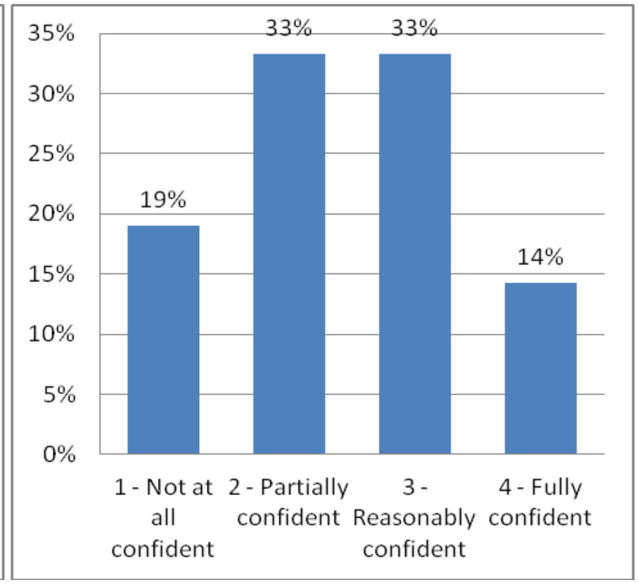



Figure 18 Confidence level of NRM 2

4. How likely are you to be able to get guidance on the use of the published NRM documents?

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| NRM 1 | ☐ | ☐ | ☐ | ☐ |
| NRM 2 | ☐ | ☐ | ☐ | ☐ |

(1- Very unlikely; 2- unlikely; 3- likely; 4- Very likely)

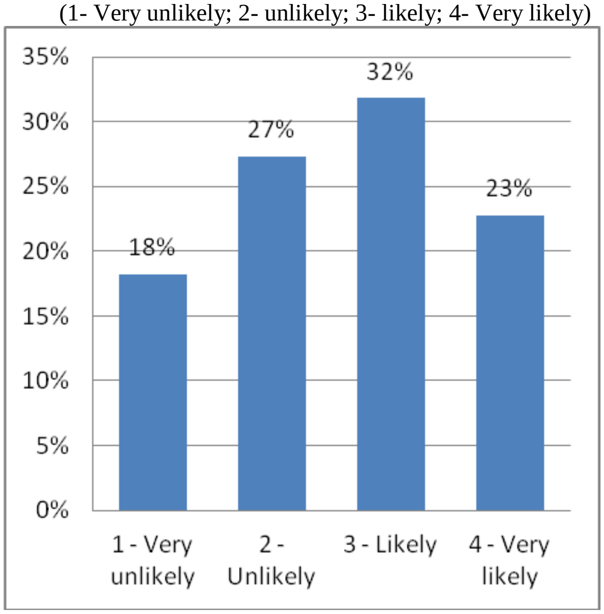



Figure 19 Confidence level of NRM 1

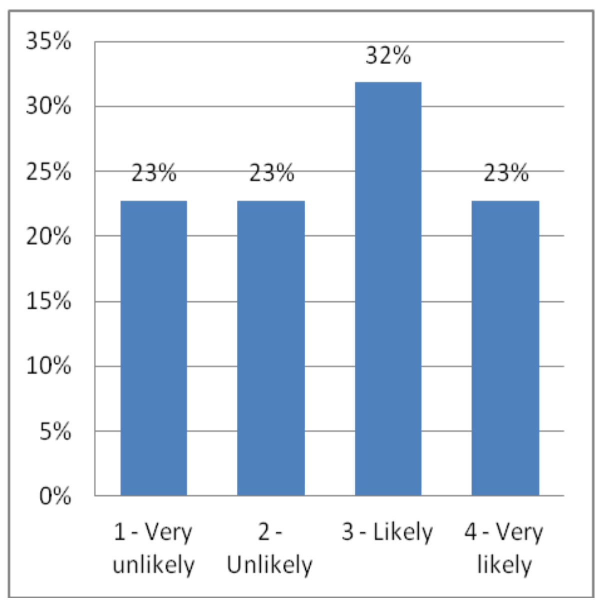
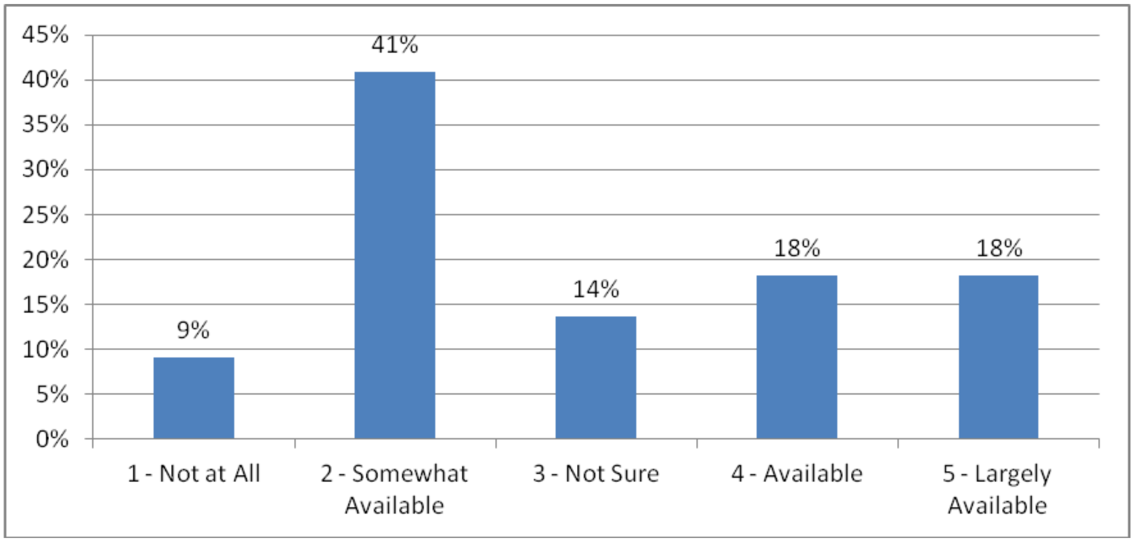



Figure 20 Confidence level of NRM 2

5. Please indicate your view on the level of accessibility/availability of data for NRM 1:

☐ 1: Not at All ☐ 2: Somewhat Available ☐ 3: Not Sure
☐ 4: Available ☐ 5: Largely Available

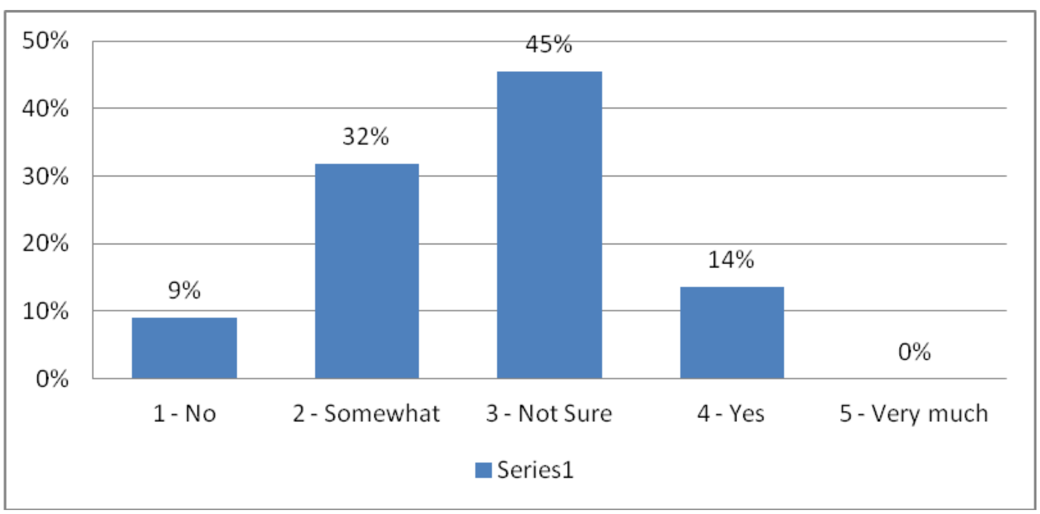



(Total No. of Responses: 22)

Figure 21 Views on the level of accessibility/availability of data for NRM1

6. Does NRM 2 present better rules of measurement than SMM7?

☐ 1: No ☐ 2: Somewhat ☐ 3: Not Sure
☐ 4: Yes ☐ 5: Very much




(Total No. of Responses: 22)

Figure 22 NRM 2 present better rules of measurement than SMM7

7. What is the extent of usage of the published NRM documents for teaching on your QS programmes?

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| NRM 1 | ☐ | ☐ | ☐ | ☐ |
| NRM 2 | ☐ | ☐ | ☐ | ☐ |

(1- Never use; 2- Occasionally/Sometimes; 3- Almost every time; 4- Frequently use)

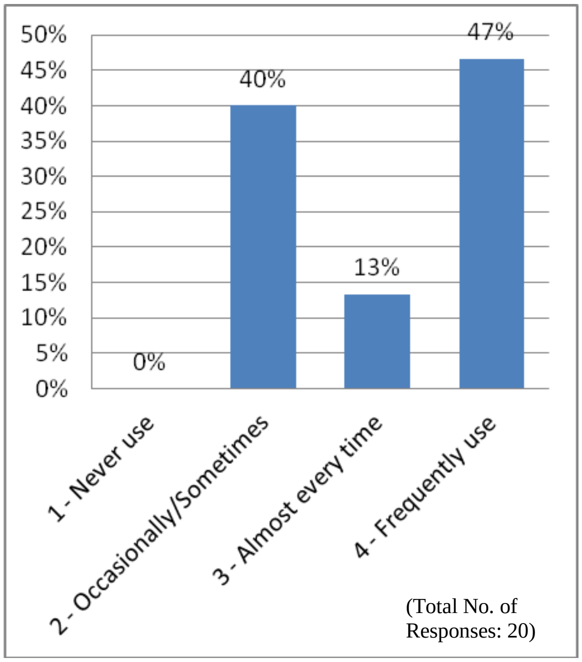



Figure 23 Usage of NRM1 for teaching

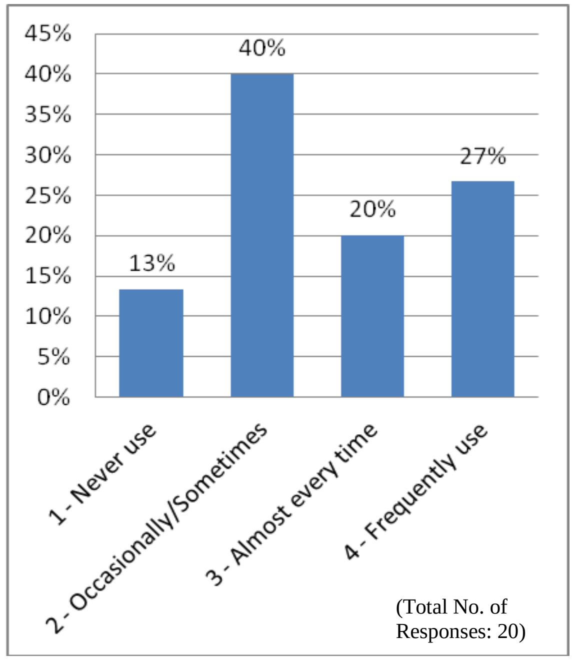


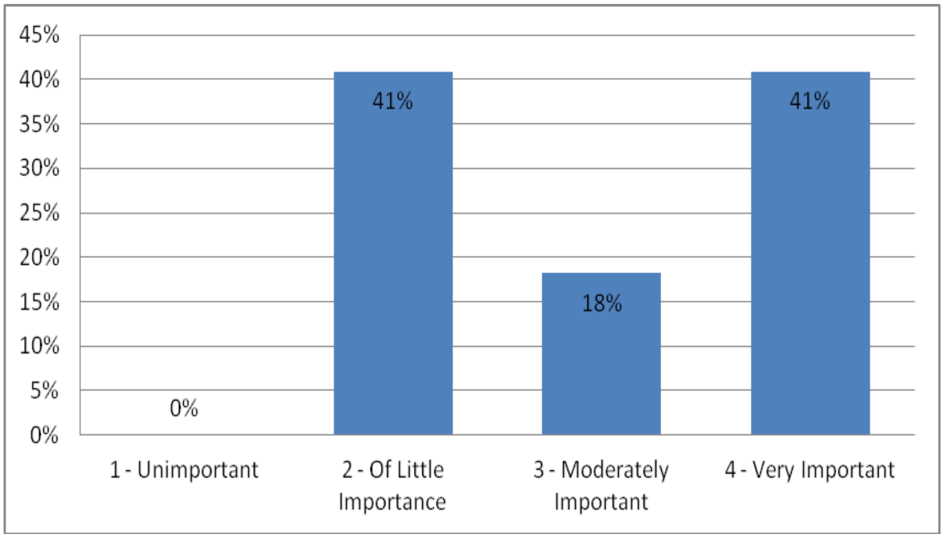

Figure 24 Usage of NRM2 for teaching

8. Any other comment(s) related to NRM?

- Urgently require examples from industry to demonstrate best practice
- There is a problem in that to make graduates employable contractors and clients in my area are still involved with SMM7 projects
- I have found that the NRM 2 document does not provide sufficient explanation and justification of the measure. Levels 1- 4 confusing. No references for comments or notes e.g. SMM7 D1-6, M1-7 etc. Referencing in the appendix unclear.
- Use of NRM2 being compulsory for UK students from Sept 2013
- No guidance produced regarding coverage and usage. More open to interpretation than SMM. NRM is more up to date than SMM but less standardisation
- NRM will become part of syllabus for new academic year 2012/13
- NRM2 to be used frequently next year
- Very limited books other than NRM itself to assist in use. No actual NRM2 BQ's / Cost Documents
- It complements BIM. BIM is not a replacement for Quantity Surveying
- The link to BIM needs to be explored and developed
- We have been told about it. I am aware but not used it

# Part 4: RICS QS and construction standards (the Black Book)

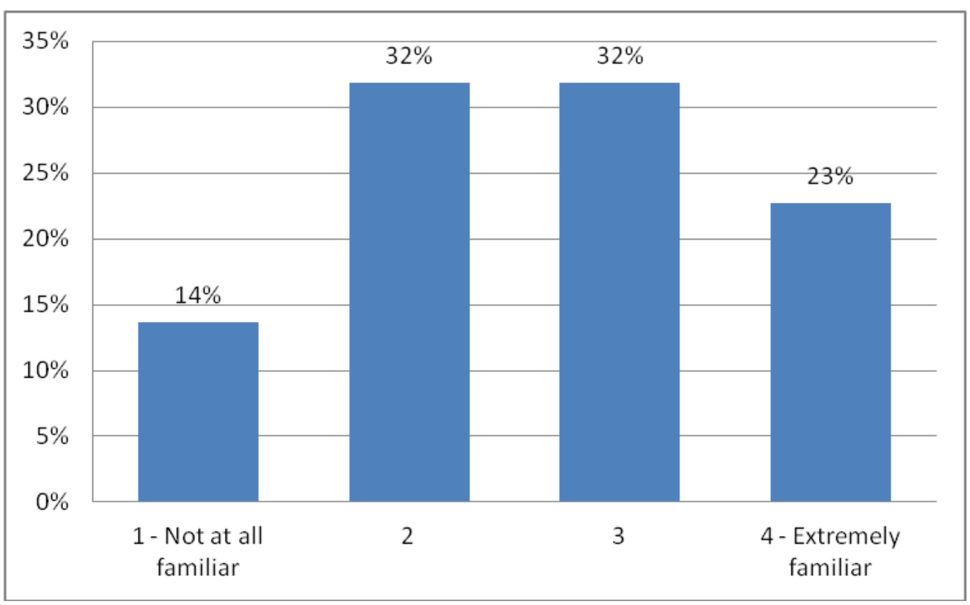
1. Rate the level of importance of the black book — 1 ☐ 2 ☐ 3 ☐ 4 ☐
   (1- Unimportant to 4- Very important)




(Total No. of Responses: 20)

Figure 25 Importance of the black book

2. How familiar are you with the black book — 1 ☐ 2 ☐ 3 ☐ 4 ☐
   (1- Not at all familiar to 4- Extremely familiar)

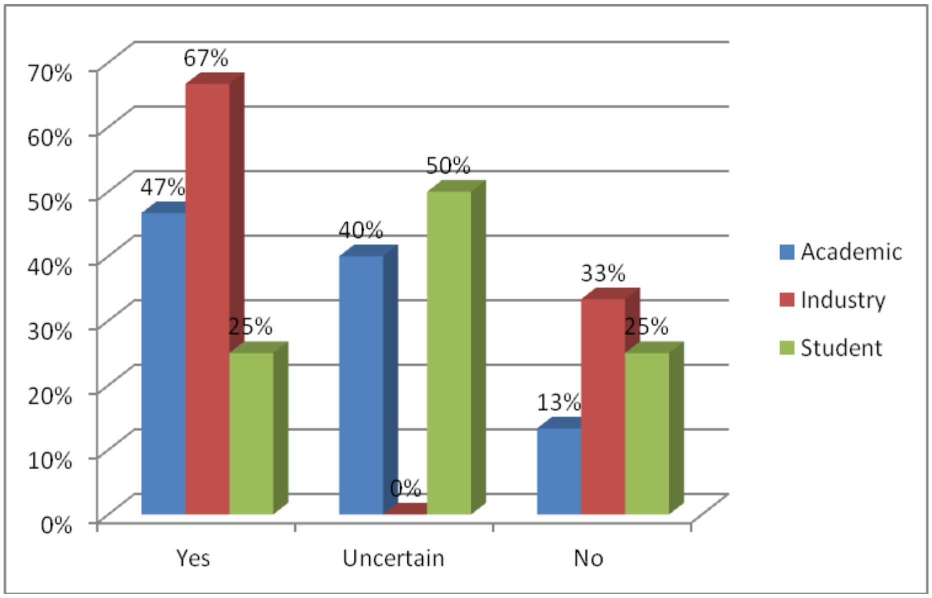



(Total No. of Responses: 20)

Figure 26 Familiarity with the black book

3. Is the black book nothing more than current good practice?

| Yes | Uncertain | No |
|---|---|---|
| ☐ | ☐ | ☐ |




(Total No. of Responses: 20)

Figure 27 Views on whether the black book is nothing more than current good practices

4. Do you currently use any of the published standards for teaching on your QS programmes?

| | Yes | No |
|---|---|---|
| Acceleration | ☐ | ☐ |
| Cash flow forecasting | ☐ | ☐ |
| Conflict avoidance and dispute resolution in construction | ☐ | ☐ |
| Construction insurance | ☐ | ☐ |
| Cost analysis and benchmark | ☐ | ☐ |
| Damages for delay to completion | ☐ | ☐ |
| Defining completion of construction works | ☐ | ☐ |
| Electronic document management | ☐ | ☐ |
| E-tendering | ☐ | ☐ |
| Retention | ☐ | ☐ |
| Valuing change | ☐ | ☐ |

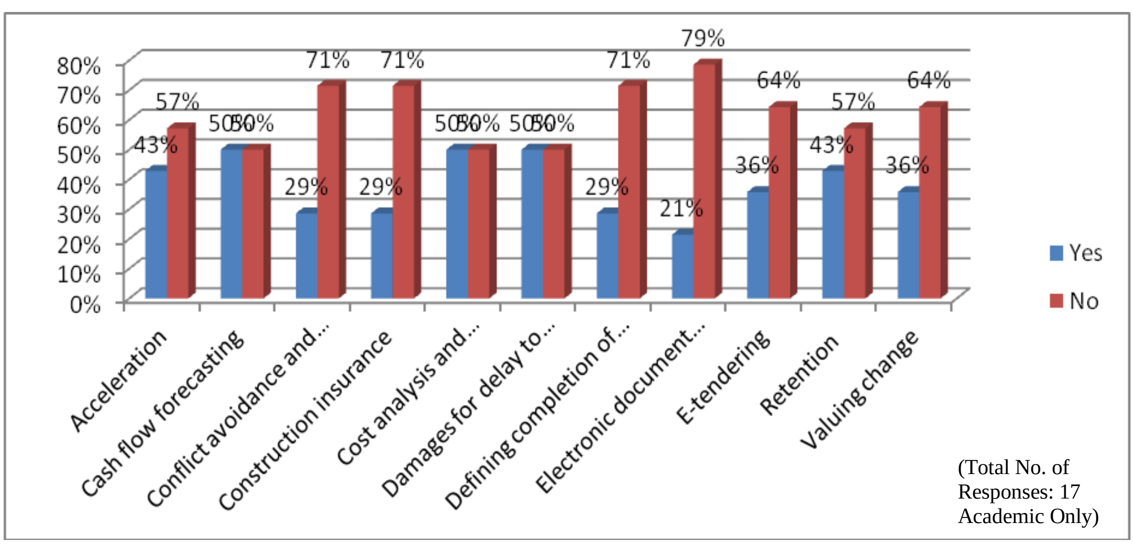


Figure 28 Usage of the black book for teaching

5. How useful is/are the standard(s) for teaching? 1 ☐ 2 ☐ 3 ☐ 4 ☐

(1- Not at all useful to 4- Extremely useful)

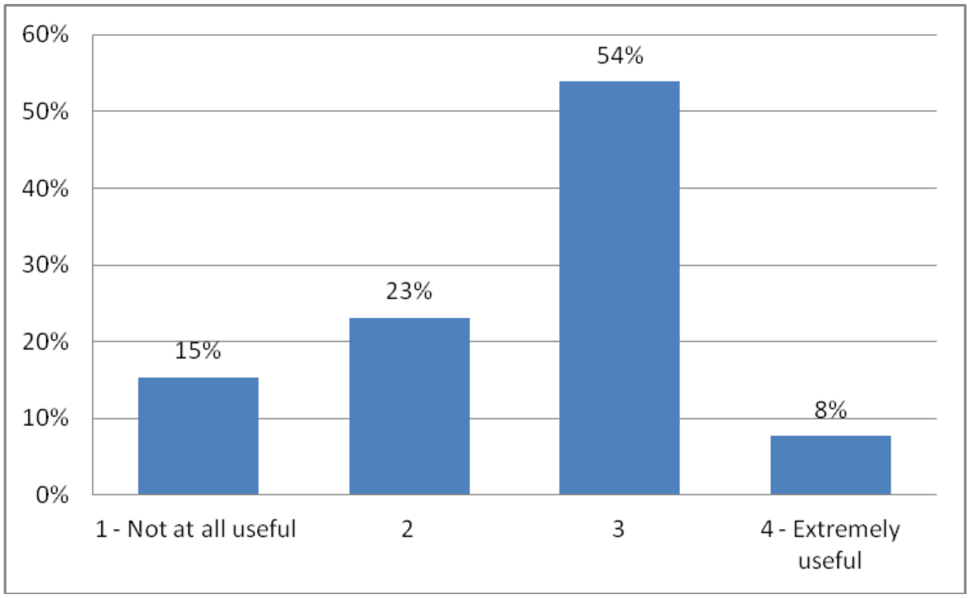



Figure 29 Usefulness of the black book for teaching

(Total No. of Responses: 17 Academic only)

6. Any other comment(s) related to the black book?

- Would benefit from greater academic input when writing/developing the Black Book standards
- Seems to be aimed more at APC candidates than experienced professionals. Best practice guidance is not easily transferred globally
- Will use other guidance notes as we progress through the academic year
- About to be used for teaching
- It defines "good" and best practice

# Part 5: Building Information Modeling (BIM)

1. Please choose which of the following definitions most closely describes BIM (please select one):

☐ BIM is the process of generating and managing information about a building during its entire life cycle
☐ BIM is essentially a design tool
☐ BIM is a process involving the generation and management of digital representations of physical and functional characteristics of a facility
☐ BIM is an integrated tool for planning, design, construction and management of projects

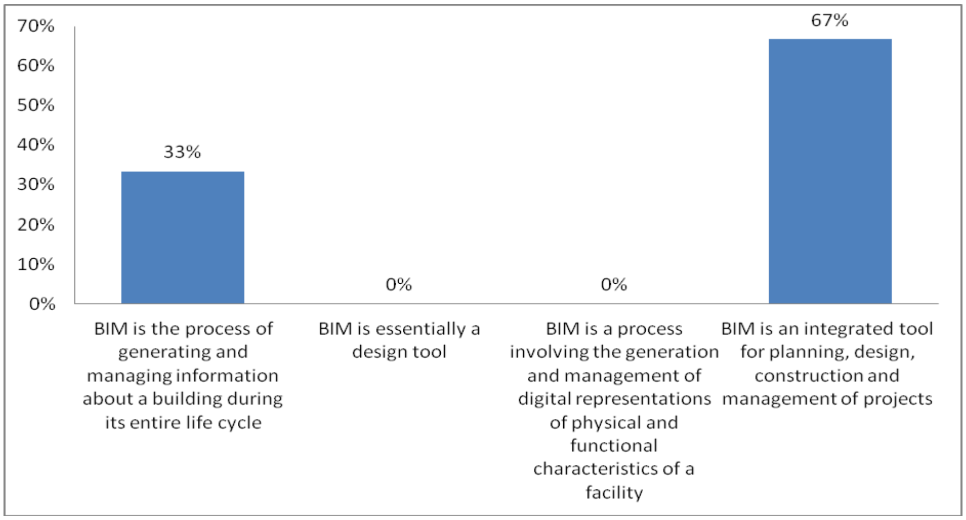



Figure 30 BIM Definitions

(Total No. of Responses: 21)

2. How familiar are you with BIM? 1 ☐ 2 ☐ 3 ☐ 4 ☐

(1- Not at all familiar to 4- Extremely familiar)

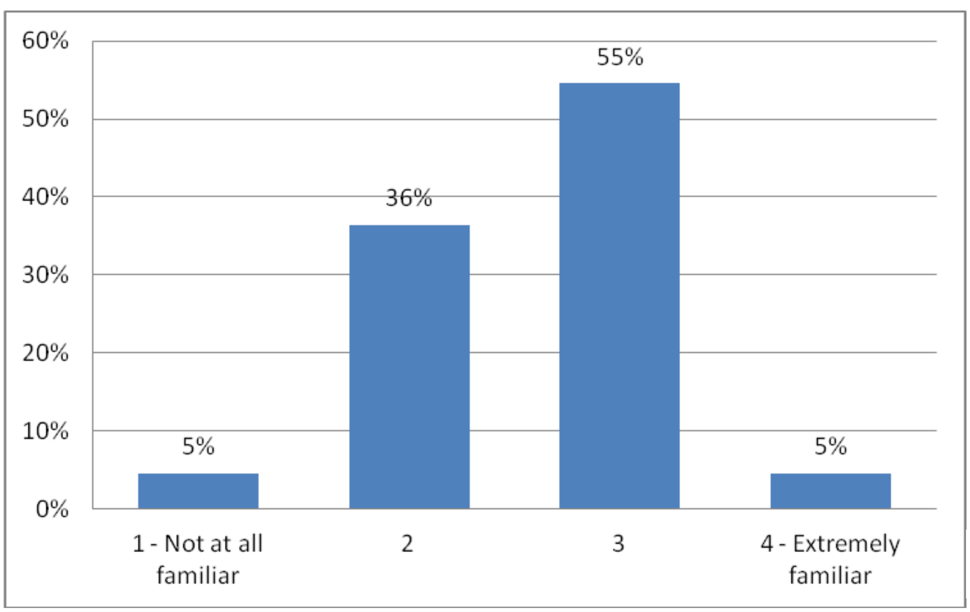
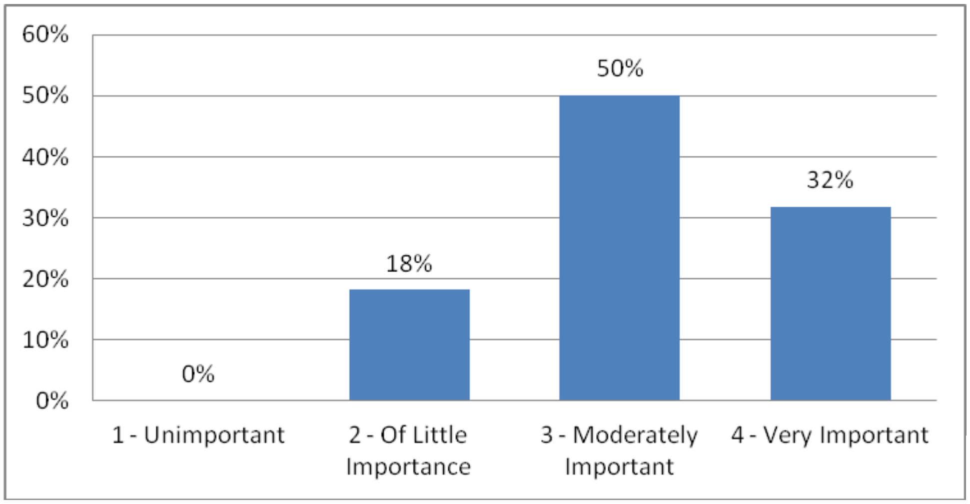



Figure 31 Familiarity with BIM

(Total No. of Responses: 22)

3. What is your perception on the importance of BIM to the role of QS?

(1- Unimportant to 4- Very important) 1 ☐ 2 ☐ 3 ☐ 4 ☐

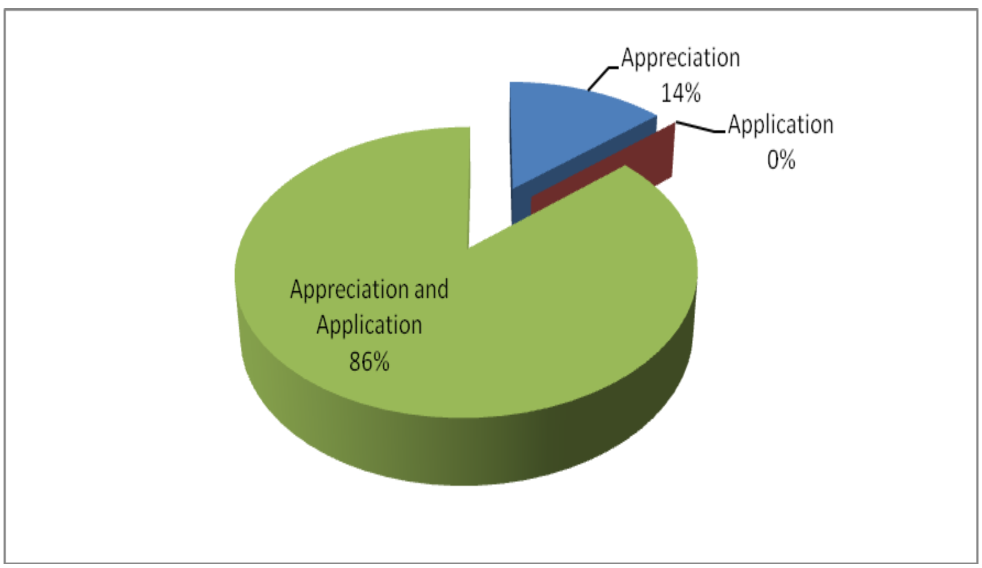



(Total No. of Responses: 22)

Figure 32 Importance of BIM to the role of QS

4. If BIM is to be included in QS curricula should it be:

☐ Appreciation ☐ Application ☐ Both ☐ Other, please specify:

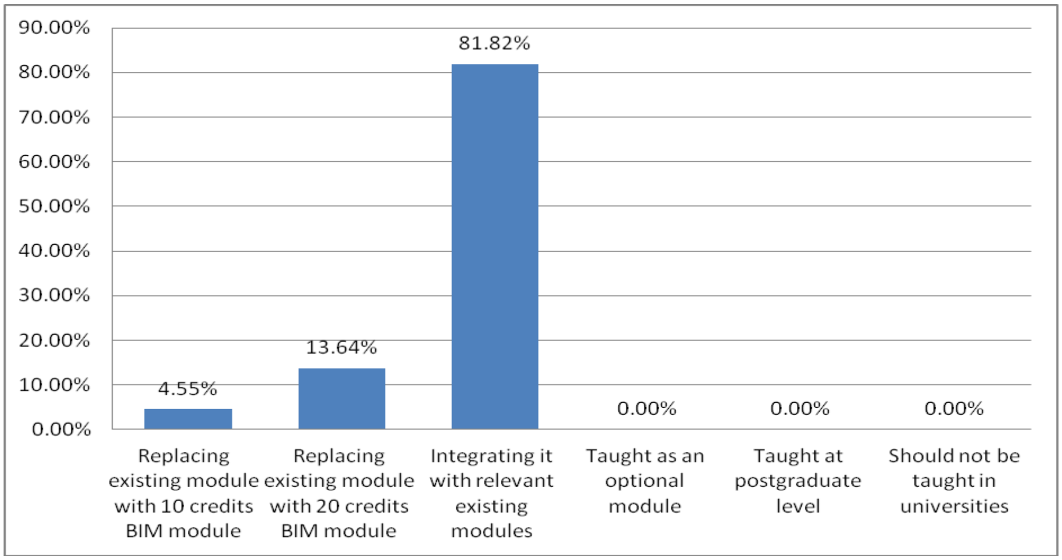



(Total No. of Responses: 22)

Figure 33 Including BIM in QS curricula

5. How should BIM be introduced to QS programme? (Please choose only one answer):

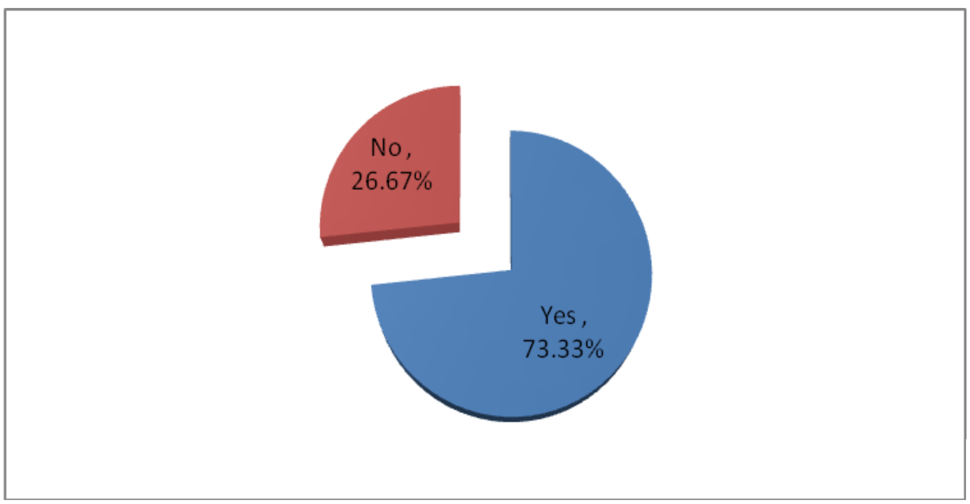
☐ Replacing existing module with 10 credits BIM module
☐ Replacing existing module with 20 credits BIM module
☐ Integrating it with relevant existing modules
☐ Taught as an optional module
☐ Taught at postgraduate level
☐ Should not be taught in universities




(Total No. of Responses: 22)

Figure 34 Views on how BIM introduced to QS programme

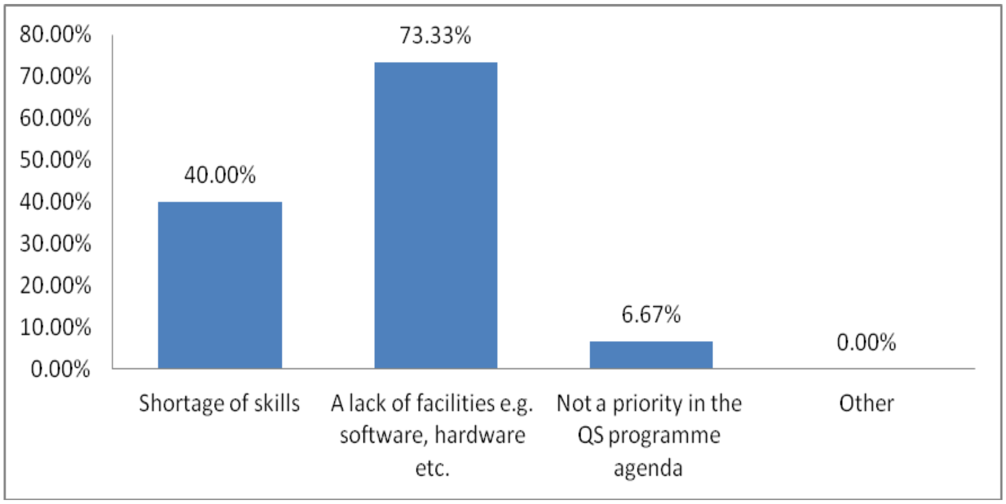
6. Do you currently teach BIM on your QS programmes? Yes ☐ No ☐




(Total No. of Responses: 19)

Figure 35 Teaching BIM on your QS programme

7. What are the barriers to the teaching of BIM on your QS programmes?
   - ☐ Shortage of skills
   - ☐ A lack of facilities e.g. software, hardware etc.
   - ☐ Not a priority in the QS programme agenda
   - ☐ Other, please specify:




(Total No. of Responses: 19)

Figure 36 Barriers to the teaching BIM on your QS programme

8. Any other comment(s) related to BIM?

- BIM is fundamental to QS education as the overall understanding of the process of construction is vital - the QS …… in cost management are therefore crucial and they need to appreciate the value of BIM and integrated working
- Which classification system to use? Purchase?
- Funding - to develop software BIM/QS Slant. It would be excellent if universities all come together and funded the development of a model that was linked to BCIS/CATO etc. to support the QS role.
- Still only used to a limited extent in practice, therefore difficult to predict whether industry will adopt it on a wide range of projects
- As more people become aware of its use and availability (software) then it will be a better tool
- There is too much hype about BIM. Concentrate on teaching the basics of Quantity Surveying first!
- The growth of 'BIM' based tools is inevitable. The application of a project 'level 2' BIM will be adopted by the government, its under application is less certain
- We want it to be incorporated into our studies
- BIM is not easy to teach, as the industry is still not aware of how it will work within the current construction industry