Engineering education quality assurance processes – an exploration of the alignment or combination of the programmatic review and accreditation processes for engineering education programmes in Ireland

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Engineering Education Quality Assurance Processes – An Exploration of the Alignment or Combination of the Programmatic Review and Accreditation Processes for Engineering Education Programmes in Ireland

Two Volumes – Volume 1 of 2

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Abstract

Engineering Education Quality Assurance Processes – An Exploration of the Alignment or Combination of the Programmatic Review and Accreditation Processes for Engineering Education Programmes in Ireland

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Key Words: Engineering Education, Accreditation, Programmatic Review

All programmes of study in Institutes of Technology in Ireland are subjected to internal programmatic review in five yearly cycles to ensure that the education programmes meet the quality assurance standards and are fit for purpose. In addition, engineering and construction programmes undergo voluntary external accreditation by their respective professional associations. The research literature indicates that these assessment types are used worldwide, in varying ways and in regular cycles, for the quality assurance of engineering education programmes. Both the programmatic review and accreditation processes differ in focus and intent and have evolved and diverged over time. Incorporation of the programmatic review and accreditation processes into a single quality assurance process or bringing the processes into closer alignment has long been an ambition of the stakeholders and gatekeepers to the engineering profession. The research question explores if the external accreditation processes of engineering programmes in Ireland can be brought into closer alignment with the internal programmatic review process of these programmes. If closer alignment is achieved, a single collaborative quality assurance process could be created or sequential occurrence of the processes within the same timeframe could be facilitated. Significant consultation has taken place with the stakeholders of these processes. The research is designed to gain insights from experts using an adopted Delphi technique methodology for data collection and the constructivist grounded theory to support the analysis of the data. The research outcomes conclude that the accreditation process of engineering education programmes can be brought into closer alignment with the programmatic review process in Institutes of Technology. The findings indicate that it is unrealistic for the processes to be combined into a single quality assurance process but the results show that aligning or linking the processes can be achieved and three options are proposed. Implications for the stakeholders are discussed. This research had yielded insights that are linked to practice and theory to illustrate originality.

Declaration

I, the undersigned hereby declare that this submission is entirely my own work, in my own words, and that all sources used in researching it are fully acknowledged and all quotations properly identified. I understand the ethical implications of my research, and this work meets the requirements of the University of Limerick Faculty of Education and Health Sciences Research Ethics Committee and the Limerick Institute of Technology Research Ethics Committee. I have published four conference papers related to this research study and two further conference papers have been accepted for publication in 2021 (See appendix D for details).

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Dedication

I would like to dedicate this thesis to my supportive and loving husband John and my wonderful children Grace, Mary, Paul and Hazel.

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Abbreviations and Acronyms

ABET	The Accreditation Board of Engineering and Technology (USA)
AHELO	The Assessment of Higher Education Learning Outcomes
APEC	The Asia Pacific Economic Cooperation Agreement
ASEE	The American Society of Engineering Education
ASIIN	The German Professional Accreditation Association
AQF	The Australian Qualifications Framework
CAO	The Central Applications Office
CAP	The Committee for Academic Policy (CNAA)
CAT	College of Advanced Technology
CEI	The Council of Engineering Institutions
CICES	The Chartered Institute of Civil Engineering Surveyors
CIOB	The Chartered Institute of Building
CNAA	The Council for National Academic Awards
CnaI	Cumann na hInnealtóirí
CoHSE	Council of Heads of School of Engineering
CONFEA	The Federal Council of Engineering and Agronomy (Brazil)
CoR	Council of Registrars
CPD	Continuous Professional Development
CTI	La Commission des Titres d’Ingénieur (France)
DES	Department of Education and Skills
EAC	The Engineering Technology Accreditation Council (Malaysia)
ECPD	The Engineering Council for Professional Development
ECUK	The Engineering Council of the United Kingdom
EERN	The Engineering Education Research Network
EHEA	The European Higher Education Area
EIJC	The Engineering Institutions Joint Council
ENAEE	The European Network for Engineering Accreditation
ENQA	The European Association for Quality Assurance in Higher Education
EQF	The European Qualifications Framework

ESG	The Standards and Guidelines for Quality Assurance
ESOEPE	The European Standing Observatory for the Engineering Profession and Education
EUR-ACE	European Accredited Engineer
EUSEC	Conference of Engineering Societies of Western Europe and the USA
FEANI	The European Federation of National Engineering Associations
FEBRAE	The Brazilian Federation of Engineering Associations
HEA	The Higher Education Authority
HEI	Higher Education Institution. This term embraces all Institutes of Technology, Technological Universities, Universities and other Colleges offering higher education programmes
HEQC	The Higher Education Quality Council
HETAC	The Higher Education and Training Awards Council
HMI	Her Majesty's Inspectorate
ICEI	The Institution of Civil Engineers of Ireland
IEA	The International Engineering Alliance
IEI	The Institution of Engineers of Ireland
IEM	The International Education Mark
IFEES	The International Federation of Engineering Education Societies
InETA	The International Engineering Technologists Agreement
IPEA	The International Professional Engineers Agreement
IQUB	The Irish Universities Quality Board
NAB	The National Advisory Board
NBCEA	The National Board of Civil Engineering Accreditation (China)
NCEA	The National Council for Educational Awards
NCTA	The National Council for Technological Awards
NFQ	The National Framework of Qualifications
NQAI	The National Qualifications Authority of Ireland
NZQA	New Zealand Qualification Authority
OECD	The Organisation for Economic Cooperation and Development

OUVP	The Open University Validation Partnership
QAA	The Quality Assurance Agency (UK)
QQI	Quality and Qualifications Ireland
RAEE	The Russian Association of Engineering Education
REEN	Research in Engineering Education Network
RIAI	The Royal Institution of Architects of Ireland
RICS	The Royal Institutions of Chartered Surveyors
SCSI	The Society of Chartered Surveyors Ireland
SOLAS	Agency of the Department of Education and Skills for Further Education and Training in Ireland
TEC	The Technician Education Council
THEA	Technological Higher Education Association
UK	The United Kingdom
UL	The University of Limerick
UKSPEC	The United Kingdom Standard for Professional Engineering Competence
UNESCO	The United Nations Educational, Scientific and Cultural Organisation
WFEO	World Federation of Engineering Organisations

Chapter 1: Introduction

1.1 Overview

All programmes of study in Institutes of Technology in Ireland are subjected to internal programmatic review in five yearly cycles to ensure that the education programmes meet the quality assurance standards and are fit for purpose. In addition, engineering and construction programmes undergo voluntary external accreditation by their respective professional associations. Both processes differ in their focus and intent and the preparation required by the programme teams and managers. The two processes emphasise different aspects of engineering education. From the research literature, it has emerged that these assessment types are used worldwide, in varying ways and in regular cycles, for the quality assurance of engineering education programmes.

Both the programmatic review and accreditation processes have evolved and diverged over time into two substantial time-consuming events. The programmatic review process is set down in Higher Education Institution (HEI) academic council policies and procedures. The accreditation process is controlled by the professional association accreditation board. These policy driven activities have a gatekeeper role in controlling admission to the engineering profession by the responsibility for managing the HEI register of engineering programmes and the Engineers Ireland’s accredited programmes and their professional engineer register.

As the processes have become more complicated, the desire to merge them has become more urgent as they have many common elements. The two processes have objectives that are expressed in a different manner, have different motivations and drivers and have been created by different entities. To ensure sustainable processes in the long term, some coming together of the processes’ objectives and implementation methodology is desirable.

Incorporation of the programmatic review and accreditation processes into a single quality assurance process or bringing the processes into closer alignment has long been an ambition of the gatekeepers to the engineering profession. The aim of this research study is to explore whether and how the external accreditation processes of engineering programmes in Ireland can be brought into closer alignment with the internal programmatic review process of these programmes. The creation of a single collaborative quality assurance process, or alternatively a sequential occurrence of the processes within the same timeframe, would make a major contribution to both practical and theoretical knowledge in engineering education.

1.2 Research Context

1.2.1 Engineering

The original formal use of the term '*engineer*' applied to the constructor of military machines (such as catapults). The word '*engine*' itself is derived from the Latin word '*ingenium*' meaning innate quality, especially mental power, hence a clever invention (OECD, 2011). The National Academy of Engineering in 2008 defined engineering as follows:

'*No profession unleashes the spirit of innovation like engineering. From research to real-world applications, engineers constantly discover how to improve our lives by creating bold new solutions that connect science to life in unexpected forward-thinking ways'* (National Academy of Engineering, 2008b).

As the design of civilian structures (buildings and bridges) developed as a technical discipline, the term '*civil engineering'* evolved to distinguish between construction of non-military projects and military engineering. Engineering has classically been defined as the profession that deals with the operation of technical, scientific and mathematical knowledge in order to use the natural laws and physical resources to help design and implement materials, structures, machines, devices, systems and processes that safely accomplish a desired objective (OECD, 2011).

Engineering is the interface between scientific and mathematical knowledge and human society. The primary activity of engineers is to conceive, design, implement and operate innovative solutions, apparatus, processes and systems and to improve the quality of life, address social needs or problems and improve the competitiveness and commercial success of society. While scientists attempt to explain '*what is'*, engineers create '*what has never been'*. While scientists ask '*why*', engineers ask '*why not?*' (OECD, 2011).

The 2008 United Kingdom Standard for Professional Engineering Competence (UKSPEC) defined professional engineering as not just a job but a mindset and sometimes a way of life. Engineers use their judgement and experience to solve problems within the limits of scientific knowledge or mathematics. Their most successful creations recognise human fallibility. Complexity is a constant companion (ECUK, 2008).

The engineering field consists of a number of disciplines such as civil, mechanical, electrical, chemical, biological, environmental, aeronautical, building services, etc. Complex future challenges are demanding more inter-disciplinary knowledge of all engineers (OECD, 2011).

1.2.2 Engineering Education

Engineering education is a unique and broad subject area. Professional associations have contributed to establishing learning outcomes and competencies to be achieved by students in degree programmes. The International Engineering Alliance (IEA) has defined engineering education as follows:

'*The fundamental purpose of engineering education is to build a knowledge base and attributes to enable the graduate to continue learning and to proceed to formative development that will develop the competencies required for independent practice*' (IEA, 2013).

Within engineering, three different educational profiles are distinguished: engineers, engineering technologists and engineering technicians. These categories may have different titles or designations and different legal empowerment or restrictions within individual (national) jurisdictions (OECD, 2011). Engineering education must be carefully planned to include a strong grounding in mathematics and science as well as training in the specific engineering discipline. Students must deal with increasingly complex problems as they proceed through the educational process (OECD, 2011).

After the advent of civil engineering, chemical, electrical and mechanical engineering evolved. There are now in excess of fifty engineering degree types. Most undergraduate (first cycle) engineering degrees are B.Eng. or applied B.Sc. degrees in the specific discipline (civil, electrical, mechanical, etc.). B.Eng. degrees are focused on theoretical and abstract thinking, creative analysis and problem solving. These programmes prepare the students well for continuing on to advanced degrees in engineering. More specialised degrees are normally offered for M.Sc. or M.Eng. degrees. Some countries offer integrated first and second cycle programmes (OECD, 2011).

In the United Kingdom, which included Ireland until 1921, the programmes were originally generally of three years duration. The structure in the UK has evolved into a four-year master's degree programme or a three-year bachelor's degree leading to a one-year master programme. In Ireland, a four-year bachelor's degree has been in place for over fifty years. Taught master's degree programmes have been in place for over twenty years (from the mid nineteen nineties). In 2004, the first master degree programme, based on a 3+2 (Bologna) structure commenced and this structure has become the norm (Coyle, 2009).

Engineering higher education programmes are available in the HEIs in Ireland; namely the universities, technological universities and institutes of technology. The universities and institutes of technology/technological universities have produced similar total numbers of engineering, construction and apprenticeship graduates in recent years. The range of engineering and construction programmes available to prospective students tends to be greater in the institutes of technology sector but this is changing. In Ireland, admission to engineering programmes is predominantly through the Central Application Office (CAO) system although there are growing numbers of students entering HEIs via direct and advanced entry mechanisms. Each year the results of the leaving certificate examination system are converted into CAO points for each leaving certificate candidate. HEI programmes are offered to prospective students based on their CAO points. Students are accepted by direct entry to a HEI programme if the programme is outside the CAO system. Advanced entry to HEIs is reserved for student entry to a programme beyond year one.

Michael Higgins, in his Engineers Ireland presidential address in 1991, considered that the generally accepted supporting arguments for choosing an engineering career are:

- Engineering is a challenging and potentially creative area of study;
- Engineering offers significant employment opportunities at home and abroad;
- Engineering is in the vanguard of modern technology and few other disciplines will provide the same understanding of the world of technology in which we live;
- Engineering is an excellent formation for many career paths;
- Engineering provides a high proportion of our leading industrialists and outstanding managers (Cox, 2019).

1.2.3 Engineering Employment

Graduates awarded a B.Sc. or B.Eng. in one of the engineering disciplines may be employed in various positions in engineering organisations, and many different types of non-engineering organisations, such as law, medicine, financial, public service and policy-making. In most cases, first cycle graduates go to work directly for engineering organisations that construct, design and produce systems or services. In most employment, the graduate will begin work under the supervision of a more senior engineer. The type of work open to first cycle graduates may be limited (technical support only) (OECD, 2011).

Graduates with second cycle degrees obtain employment in the same types of engineering organisations as first cycle graduates and are more likely to enter higher level specialised engineering positions with a research focus, more loosely defined problems and management responsibility (OECD, 2011).

Some professional associations require a second cycle degree to practice. Other professional associations believe the first cycle degree is sufficient to enter their profession. The legality for graduates to practice without direct supervision by an experienced engineer varies by country. In order to become a licenced/registered engineer, graduates may be required to complete a period of work experience (OECD, 2011). The total formation of the professional or chartered engineer in the UK and Ireland is deemed to require, in addition to completion of an accredited engineering degree programme, a number (normally a minimum of four) of years working in industry, developing a range of professional engineering competencies which are then tested through a professional review process (Coyle, 2009).

1.2.4 International Context of Engineering Education

Since the 1980s there has been a growing need for an international regulatory framework and the capacity to understand, transfer and recognise qualifications. Most countries have developed similar approaches to the recognition of engineering education qualifications based on learning outcomes.

Australia has developed its Australian Qualifications Framework (AQF) which comprises nine levels and associated titles and is based on learning outcomes (Education Australia, 1995). New Zealand and South Africa have similar qualifications systems also based on learning outcomes. The ten levels in the National Qualifications Framework of New Zealand is designed to provide nationally recognised standards and qualifications as well as recognition and credit for a wide range of knowledge and skills (New Zealand Qualification Authority, 2020).

The introduction of '*ECriteria (2000)'* for the accreditation of engineering education by the Accreditation Board of Engineering and Technology (ABET) followed what was happening globally, including Australia and New Zealand. ABET formulated its generic learning outcomes to be reached by every engineering programme and this approach has become one of the role models for the development of similar trends worldwide (ABET, 2000).

The American Society for Engineering Education (ASEE) published *The Attributes of a Global Engineer* defining the desired competencies and characteristics needed by engineers to effectively live and work in a global context. The ASEE endeavoured to define learning outcomes per attribute and to determine where in an engineer's educational preparation the attributes need to be introduced and assessed (Hundley & Brown, 2013).

In Europe, a common higher education area has emerged and with it a common framework for teaching and learning in higher education has evolved which identifies the need for learning outcomes to be utilised at the disciplinary level. In 2006, the European Commission launched a *European Qualifications Framework (EQF)* seeking to encompass all types of learning in one overall framework (OECD, 2011). There are many policy developments including the Bologna Declaration (1999), guidelines for quality assurance developed by the European Association for Quality Assurance in Higher Education (ENQA) (ESG, 2015), the establishment of the European Federation of National Engineering Associations (FEANI) in 1951 and the European Network for Accreditation of Engineering Education (ENAEE). ENAEE was founded in 2006 and authorises accreditation and quality assurance agencies to award the *EUR-ACE label (European Accredited Engineer)* to their accredited engineering degree programmes (ENAEE, 2020). To be authorised, an agency must satisfy the standards published in the EUR-ACE Framework Standards and Guidelines (ENAEE, 2015).

EUR-ACE identified five categories of learning outcomes for entry to the engineering profession as basic and engineering sciences, engineering analyses and investigations, engineering design, engineering practice and generic skills. The five categories of learning outcomes, together with the competencies set out in the International Engineering Alliance's (IEA) *Graduate Attributes and Professional Competencies* document are the basis for engineering accreditation and international mutual recognition agreements including the Washington, Sydney and Dublin Accords (IEA, 1989), (IEA, 2001), (IEA, 2002). This harmonisation effort enables mutual recognition of accredited educational programmes, (Wo, 2013).

European countries followed the global trend of accrediting engineering programmes based on whether the programme delivers the learning outcomes set out in the relevant standard. In Great Britain, the Quality Assurance Agency (QAA) and the Engineering Council (ECUK) developed an engineering graduate outcomes standard called the *UK Standard for Professional Engineering Competence (UK-SPEC).*

The Commission des Titres d'Ingénieur (CTI) in France accredits engineering programmes by expected learning outcomes (CTI, 2020). The Swedish Higher Education Ordinance lists the national requirements for Swedish engineering degrees (Ministry of Education and Research of Sweeden, 2020). Other examples are given in Chapter two, Section 2.6.3.

Within the United States of America there is uniformity among both private and public university programmes in engineering education, due in part to the acceptance of ABET's authority in setting standards for curriculum content. Within the European Union there is greater programme variety, although some degree of harmonisation has been achieved due to the Bologna Declaration (Coyle, 2009). There is a common understanding throughout the world of what an engineer is supposed to know and be able to do (OECD, 2011).

1.2.5 Quality Assurance of Engineering Education Programmes

For engineering education, two forms of quality assurance processes are currently in place, validation and accreditation. The validation (or revalidation) process is an internal HEI process called *'programmatic review'* in Institutes of Technology/Technological Universities. The accreditation process is an external process assessed by the relevant professional association. Different aspects of engineering education are measured by the processes and they differ in the self-evaluation processes undertaken by the programme teams.

Church (1983) defined validation as follows:

'*It is the process of scrutinising a proposed degree scheme, and of deciding whether or not it should be approved as being of an appropriate standard for the award to which it is intended to lead and, if this proves to be the case, of then specifying the conditions which must be fulfilled if the programme is actually run'*.

Validation became a familiar word in the early 1970s. The development of validation was historically contingent and conditioned. Its role cannot be fully understood without reference to the historical situation. Validation was created by the National Council for Technological Awards (NCTA) to ensure the programmes created by new institutions were comparable to those in universities (Church, 1983). The term 'validation' was first used in the James report (1972) which mentions the willingness of the University of Wales to 'validate' the Dip. H.E. in the principality. It then appeared in a government white paper in 1972 (James, 1972).

Validation has come to be regarded as a process, which is an evaluation of education programmes (Church, 1983).

Programmatic review is a cyclical mandatory quality review process under the Standards and Guidelines for Quality Assurance (ESG) in the European Higher Education Area (EHEA) (ESG, 2015). HEIs assess their higher education programmes for fitness for purpose and sets down plans for future progress over the next five years. It is a significant part of the quality assurance process as it embraces the concept of continual improvement and is a self-monitoring activity carried out under the auspices of the academic council (Kyne, 2020). The programmatic reviews generally occur on a faculty or department wide basis where all programmes are amended to include new technologies, new delivery modes and new industry developments.

Accreditation has been defined as

'*the process of recognising education institutions and the various programmes they offer for performance, integrity and quality which entitles them to the confidence of the educational community and the public*' (Journal of Higher Education, 1979);

'*Accreditation provides assurance that a HEI programme meets the quality standard of the profession for which that programme prepares graduates'* (ABET, 2020).

The definition of accreditation adopted by the Permanent Steering Committee of the European Standing Observatory for the Engineering Profession and Education (ESOEPE) in 2001 gives the relationship between accreditation and quality assurance as

'Accreditation is the primary quality assurance process used to ensure the suitability of an educational programme as an entry route to the engineering profession' (ESOEPE, 2001).

The purpose of accreditation is to evaluate engineering education programmes against national and international standards agreed upon and accepted by the international academic community, relevant professional associations and industry stakeholders. Accreditation is normally conducted by voluntary non-government agencies and professional associations.

Accreditation is seen to be just as demanding as validation (Church, 1983). Accreditation tends to show that programmes have been benchmarked against a national or international standard whereas validation is viewed as a more programme developmental process. Accreditation cannot be something wholly divorced from validation (Warren, 1976).

1.3 Rationale for the Research

1.3.1 Quality Assurance Processes in Engineering Education

In engineering education quality assurance, there are two major stakeholders, the state and professional associations, acting as gatekeepers and controllers for the roll out of policy admission to the engineering profession. The processes have a gatekeeper function where admission to a professional elite is controlled by adherence to the relevant policies.

Quality assurance in higher education is the totality of systems, resources and information devoted to maintaining and improving the quality and standards of teaching, scholarship and research and of students' learning experience (The Quality Assurance Agency, 1998). Irish institutes of technology hold designated awarding body status to make their own awards from level 6 Higher Certificates to level 9 Master degrees and are obliged to cooperate with, and have regard to guidelines issued by, Quality and Qualifications Ireland (QQI) (QQI, 2016). All HEIs are required to periodically review their programmes to ensure that they achieve the objectives set for them and respond to the needs of students and society (ESG, 2015).

The HEI's academic council, through the Registrar's office, manages the *programmatic review* process in consultation with the relevant Dean/Head of School. Academic council documents set out the policy and processes to be followed for the programmatic review process, which varies by HEI but are essentially the same (LIT, 2020 - 2021). Programmatic review involves a root and branch examination of programmes of study and how they have been delivered in the previous five years and how they plan to be delivered in the subsequent five years (QQI, 2016). Programmes are changed to ensure that graduates have the requisite skills and competencies to prepare them for the world of work.

In contrast to the internal process of programmatic review, external *accreditation* of all university and institutes of technology engineering programmes in Ireland has been carried out by Engineers Ireland since 1982. Engineering education programmes which satisfy the appropriate criteria laid down in the *Accreditation Criteria for Professional Titles* document are deemed to meet the education standard required of individuals seeking one of the registered titles of chartered engineer, associate engineer and engineering technician (Engineers Ireland, 2014). The accreditation process, as laid down in the document, is consistent with international best practice. Engineers Ireland have also published a supporting guidance document titled *Procedure for Accreditation of Engineering Education Programmes* (Engineers Ireland, 2015).

Accreditation of engineering programmes by professional bodies such as Engineers Ireland, the Society of Chartered Surveyors Ireland (SCSI) and others, are a vital part of ensuring that programmes are fit for purpose and that graduates have the requisite skills to be able to participate fully in their chosen profession (RICS, 2019).

Unlike programmatic review, the accreditation process is voluntary and usually embraces a combination of self-evaluation, external peer review based on a site visit and the final decision is made by the responsible accreditation board (Engineers Ireland, 2015). The focus of the accreditation process has changed significantly in the last ten years towards the measurement of student achievement of learning outcomes which has gained worldwide acceptance and is a driving force for ensuring the quality of engineering education programmes.

1.3.2 Concerns and Challenges of the Quality Assurance Processes in Engineering Education

The programmatic review and accreditation processes have evolved and diverged over time from humbler beginnings into substantial events and at the same time the importance of engineering quality assurance reviews and accreditation has increased. The programmatic review process emphasises a prospective view for the next five years whereas the Engineers Ireland accreditation process retrospectively assesses engineering programmes.

These policy driven processes have many stakeholders and gatekeepers with different priorities and expectations but have considerable overlaps. The programmatic review process is principally regarded as a review of the strategic focus and programme delivery statistics of the faculty/school or department while the accreditation process is regarded as a more rigorous examination of the programme content. The length of preparation and implementation of the processes has increased with time. Engineering programme teams have expressed the view that they are constantly engaged in an evaluation of their programme and are suffering from review fatigue. The commonalities across the processes are viewed by staff as repetitive. For instance, asking employers to be interviewed on the same topic by two separate panels seems unnecessary.

The range of engineering programmes in schools/faculties of engineering, in the institute of technology sector in Ireland, produces profiles of programmatic review and accreditation activities which vary by year and professional association.

Preparation of the documentation and gathering of evidence for the programmatic review and accreditation events normally commences at least one year in advance of the event. Interaction with the variety of professional bodies in the engineering and construction field, each with their own agenda and process, is time consuming. The scale of the challenge for managers and programme teams depends on how many professional associations accredit their programmes and whether all the programmes are examined at the same time. Aligning of the processes into one major process every five years would release significant time for other initiatives and new programme development.

My own experience of both processes, in my professional role, over the last five years has not only given me insights into this problem but has also placed me in an ideal position to investigate possible solutions. I currently manage five departments in my faculty. Programmatic review of the faculty's programmes continued from early 2015 through to late 2018. Accreditation by Engineers Ireland commenced in 2017 and was completed in 2020. Accreditation by other professional associations (at least two per year) started in 2016 and continued to 2019. As well as my own professional responsibilities, I am a member of the Engineers Ireland accreditation board which manages their accreditation process in all HEIs in Ireland. All issues relating to the Engineers Ireland accreditation process are discussed and resolved at the accreditation board meetings. I regularly participate in programmatic review and Engineers Ireland accreditation panels in other HEIs which gives me an insight into how the processes are applied and valued in all HEIs.

1.4 Research Question and Objectives

1.4.1 Research Question

The research question for this study is '*How can the external accreditation process of engineering education programmes in Ireland be brought into closer alignment with the internal quality assurance programmatic review process of these programmes?'*

The closer alignment that will result from this study will enable merging or converging of two major quality assurance processes that have different drivers, motivations and outcomes. If some form of closer alignment is the outcome of this study, then a single collaborative quality assurance process for engineering education may be possible or sequential occurrence of the processes within the same timeline may be facilitated.

1.4.2 Research Objectives

Considerable consultation with the stakeholders to the processes occurred at the beginning of this research which identified the likely inhibitors to bringing the processes into closer alignment. These areas of contention, and the feedback from the focus group meetings, were gathered together into nine objectives to be explored in this research study.

The research objectives for this study are:

1. To probe the willingness of stakeholders to engage with the concept of bringing the quality assurance processes into closer alignment;

2. To identify and critically appraise the advantages, disadvantages and barriers to bringing the engineering education programmatic review and accreditation processes into closer alignment;

3. To explore and appraise the power, responsibilities and influence of the primary stakeholders to the quality assurance processes for engineering education;

4. To identify the most appropriate method of combination/alignment of the processes and to examine if the internal programmatic review process can be enhanced by using the evidence-based methodology of the Engineers Ireland accreditation process;

5. To investigate if the Engineers Ireland accreditation process should be voluntary or mandatory when the processes are in closer alignment;

6. To determine and appraise the most suitable synchronisation of the review cycles and changes to the site visit agenda(s) of the programmatic review and accreditation processes to facilitate closer alignment;

7. To explore and critically evaluate the possibility that the validation and accreditation objectives can converge into a single set of objectives to support the alignment or combination of the quality assurance processes;

8. To identify and scrutinise how communication and liaison can be managed between stakeholders and organisations for the revised process(es);

9. To evaluate and investigate if validation and accreditation should remain independent outcomes.

1.4.3 Scope of the Research

This research is limited in scope to a comparison between the programmatic review quality assurance process in institutes of technology and the Engineers Ireland accreditation process. There are other professional associations within the engineering and construction disciplines that have their own accreditation processes. It is envisaged that any closer engagement between the Engineers Ireland accreditation process and the programmatic review process could be extended to other professional associations and their processes, with appropriate adjustments.

The closer engagement between the two types of quality assurance processes is intended to be an institute of technology sector wide initiative, which may not translate to engineering programmes in universities, or to engineering programmes in other jurisdictions.

1.4.4 Important Concepts and Variables

Currently, the programmatic review and accreditation processes are entirely independent with separate entities responsible for managing and implementing the processes. Programmatic review and accreditation may occur at different times, often years apart. The two processes have similar, but different, objectives generated in isolation from each other. The two process outcomes of validation and accreditation are regarded as separate decisions which have national and international meaning. Both processes have national and international drivers which are relatively independent of each other.

Engineering and construction programmes are accredited by various professional associations who may be in competition with each other for members. Each professional association maintains its own accreditation process, so engineering programmes may have many masters, if accredited to more than one professional association.

1.4.5 Significance and Value of the Research

Professional association accreditation policies cannot be enabled without engagement with engineering programmes and they in turn need the seal of accreditation so that their graduates can be elected into a profession (Thom, 1998). The pursuit of accreditation has become mandatory for HEIs as the consequences of not being accredited means graduates would not be able to practice as professional engineers (Said, et al., 2013).

The benefits of successful achievement of programmatic review and accreditation for the HEI include academic reputation, global and national recognition, academic improvement, educational competitiveness, public accountability, guarantee of quality and international mobility for graduates. The professional associations benefit by remaining as the gatekeepers and controllers to the engineering profession.

Incorporation of the programmatic review and accreditation processes into a single process or bringing the processes into closer alignment could minimise review fatigue, duplication of effort and allow the processes to be completed in the same timeframe. A single set of validation and accreditation objectives and programme outcomes would facilitate the convergence of the processes for the institute of technology sector of higher education.

The benefits to the engineering community could be a reduction of process overlaps, a reduction of review activity, significant savings in time and effort while ensuring that the engineering programme is reviewed academically and professionally within the same timeline. An investigation into the impact of combining or aligning both processes would establish the need for a high-level agreement between the primary stakeholders and gatekeepers to the processes which could enable closer alignment of the processes and a single document submission which would cater for the requirements of both processes. This agreement could strengthen engineering education provision and ensure the sustainability of both processes over time as well as allowing utilisation of a forward and backward lens when reviewing engineering education programmes.

1.5 Theoretical Framework and Research Design

1.5.1 Theoretical Framework

The philosophical approach of the research question and objectives gave rise to a theoretical framework for this research study with the following characteristics:

- A pragmatic paradigm;
- A subjective ontology with multiple realities;
- An interpretivist epistemology and axiology where the researcher's perspectives and values are made known in the research;
- Constructivist grounded theory and the Delphi technique for data collection and analysis. Data collection was in three phases using an adapted Delphi technique of interviews and a questionnaire.

A rationale for the choice of theoretical framework is provided in chapter three of this thesis which highlights the consistent approach from paradigm selection through to data collection and analysis.

1.5.2 Research Design

An adapted Delphi technique of three rounds form the core of the research design together with considerations of validity and reliability. The design and implementation plan for this research consists of seven main steps as follows:

- Consultation with stakeholders and gatekeepers to the processes;
- Identification of the research participants;
- Generation of initial interview questions and the holding of the focus group meetings;
- Application for ethical approval from the University of Limerick (UL) and Limerick Institute of Technology (LIT);
- Conduct the Delphi technique round one interviews and analyse the outputs;
- Create the round two questionnaire from the round one outputs and send to the research participants. Analyse the questionnaire outcomes;
- Create the round three questions from the round two outcomes and analyse the interviews.

Details of the research design implementation is provided in Chapter four of this thesis.

1.6 Structure and Content of the Thesis

The literature review chapter (Chapter two) gives an insight as to how the programmatic review and engineering accreditation processes emerged from the development of engineering and technological higher education. The engineering education system and policy development in the Republic of Ireland and the United Kingdom is considered. Quality assurance and curriculum development of engineering programmes, including the programmatic review process is explained. The emergence of engineering professional associations and their accreditation processes is described.

The research methodology chapter (Chapter three) explores the philosophical basis of the research study and discusses the reasons behind the choice of research paradigm, ontology, epistemology, axiology, methodology and research methods. The content of the chapter follows these philosophical aspects of the research design from paradigm selection through to research methods and concludes with my interpretation of the common traits across the research design.

The content of the research design and implementation chapter follows the consultation phase of the research, application for ethical approval, identification of the research participants, focus group meetings, development of the research questions for round one, creation of the questionnaire, completion of the interviews and concludes with a summary of the research design stages and implementation timeline.

The research findings are separated into three chapters to mirror the data collection phases of the Delphi technique. All three rounds were analysed in a different way, according to the nature of the data collected, but followed an overall analysis by question, analysis by theme and the analysis by group type and engineering discipline. The research findings for each Delphi technique round were gathered together into narrative summaries and linked to the research objectives. Each chapter concludes with a summary of the themes that had achieved participant consensus.

Interpretation and discussion of the research findings chapter follows the response to the research question and each of the nine research objectives based on the findings, identifies unexpected findings, outlines the limitations of the research study, explores the implications of the research findings for the process stakeholders and concludes with a summary of the outcomes of the research.

The content of the conclusions and recommendations chapter briefly addresses the research question and each of the nine research objectives based on the research findings, summarises and reflects on the research, makes recommendations for future research, considers the originality of the research and its contribution to knowledge and concludes with a summary of the outcomes of the research.

Chapter 2: Literature Review

2.1 Overview

2.1.1 Focus of the Literature Review

This literature review provides an insight as to how the programmatic review and engineering accreditation processes emerged from the development of engineering and technological higher education in the British Isles. Quality assurance and accreditation has been extensively discussed in all forms of literature but the emphasis here is on their application to engineering education. Influences and influencers will be discussed and reviewed. The emergence of the Republic of Ireland's engineering higher education system resembled and followed closely what was happening in the United Kingdom, the European Union, the USA and Australia.

Both the programmatic review and the Engineers Ireland accreditation processes have evolved from modest beginnings into sizeable events in the institute of technology sector in Ireland. Universities have developed similar, but not the same, quality assurance systems. This literature review focuses on the emergence of these processes in the engineering sphere and their importance to the design of engineering education programmes. The reports which impact significantly on this research study are considered. The PARN report discovered that the two quality assurance processes operate independently of each other (PARN, 2017). Detailed examination of how to bring these processes into closer alignment has not been addressed in the literature. The essence of this research study addresses this deficiency.

In my role as Dean of Faculty, I engage with five yearly cyclical programmatic reviews for the faculty's programmes as well as accreditation visits from professional associations (at least two per year). This involves participation in school of engineering programmatic reviews and accreditation panels in other institutes of technology and universities in Ireland as well as being a review member on IEA panels in other jurisdictions. Participation on the Engineers Ireland accreditation board gives the researcher an 'insider' insight on how accreditation is conducted in all HEIs in Ireland.

The content and organisation of this chapter follows seven streams of the Republic of Ireland engineering education system and policy development, engineering education development, quality assurance and curriculum development for engineering education (including the programmatic review process), the emergence of engineering professional associations, accreditation of engineering education programmes, review of relevant reports and concludes with a summary comparison of the development of the quality assurance processes.

2.2 The Republic of Ireland Engineering Education System and Policy Development

An overview of the Irish higher education system from the 1960s, a definition of education policy, a description of the quality assurance and accreditation policy documents for engineering education, the impact of global influences on policy formation, the effect of policy communities and networks on policy development and the gatekeeper role of professional associations and HEIs are discussed in this stream of the chapter.

2.2.1 A Brief Overview of The Irish Higher Education System from the 1960s

The Irish education system has undergone significant change in the past sixty years due, in no small part, to the strongly interventionist role adopted by the Irish state in pursuit of economic development from the early 1960s onwards (Heraty, et al., 2000). Up until the 1960s, training outside the apprenticeship system was virtually non-existent. The Organisation for Economic Co-operation and Development's (OECD) *Investment in Education* report in 1965 highlighted some of the more salient weaknesses and inequalities of the system, and set the agenda for many subsequent developments (Gleeson, 1998). Following this report, free second level education was introduced in 1966.

Three distinct levels of schooling exist within the Irish educational system: primary level, secondary level and higher-level education. Second level education was characterised as academic in orientation and was generally intended to prepare students for third level education and white-collar occupations (Garavan, et al., 1995). Vocational schools were seen to provide a more technically oriented education and practical training in preparation for subsequent employment.

In the last sixty years OECD reports have compared education provision and attainment across OECD countries and have highlighted perceived inherent weaknesses in national systems including Ireland. The limited provision of vocational education and training was discussed in 1996. There has been a concerted effort by the Irish government to address these weaknesses over the years which has led to increased numbers of students attending higher education. The link between education and employment is well established where the attainment of educational qualifications impacts critically upon the graduate's ability to successfully gain and retain employment (Heraty, et al., 2000).

The Irish vocational training system originated with the guild system around the eleventh century and developed with considerable statutory reform in the twentieth century, most notably the Industrial Training Act of 1967. The guild system operated through a process of controlled apprenticeships. Today's vocational training is provided by the SOLAS statutory apprenticeships set up under the Industrial Training Act of 1967 and includes the new generation apprenticeships, developed since 2016, and managed by industry and education provider consortia. The Irish educational system is well established and the quality of higher education is internationally recognised and borne out by the relative ease with which Irish graduates find employment (Heraty, et al., 2000).

2.2.2 Educational Policy

Rizvi & Lingard (2010) argue that the most succinct and durable definition of policy was provided by David Easton in 1953 as '*the authoritative allocation of values*' (Easton, 1953). O'Buachalla (1998) is of the view that this definition needs to be expanded to include purposeful activity and embraces Harman's (1999) definition of public policy as

'*Policy refers to the implicit or explicit specification of courses of purposeful action being followed, or to be followed, in dealing with a recognised problem or matter of concern and directed towards the accomplishment of some intended or desired set of goals.'*

The Minister of Education is responsible at government level for the formation, direction and funding of education policy. The Minister operates through the agency of the Department of Education and Skills and the Higher Education Authority (O'Buachalla, 1998). There were many reports and Acts of the Oireachtas over the years to improve aspects of the education system including the *Labour Services Act* in 1987, the *Culliton Report* of 1992 and the *Government White Paper on Human Resource Development* in 1997. Economic factors have assumed a pivotal role in the creation of education policy in recent times (Murphy, 2007).

Zhu & Jesiek (2014) consider that education policies are not determined but shaped by various cultures as seen in the global trend towards accreditation frameworks based on learning outcomes. Rizvi & Lingard (2010) agrees that global policies do not affect all educational systems in the same way but are filtered through national political and cultural traditions. Education policy has traditionally emanated from a national government and exists in context, but this is changing with the advent of policy communities.

2.2.3 Quality Assurance Policy Documents and Standards for Engineering Education

The systematic development of robust quality assurance procedures in higher education was heralded in the 1992 *Green Paper on Education* (Dept. of Education and Science, 1992) and expanded in the 1995 *White Paper on Education* (Dept. of Education and Science, 1995).

Quality and Qualifications Ireland (QQI) are a national agency who implement, promote and maintain the National Framework of Qualifications (NFQ) in Ireland and apply European education standards and guidelines. QQI monitors all registered higher education providers where the QQI policies and standards provide the criteria used for monitoring compliance with these standards. The National Framework of Qualifications is a framework through which all learning achievements may be measured and related to each other in a coherent way (QQI, 2003).

From January 1st, 2020, all Higher Education Institutions (HEIs) in Ireland hold designated awarding body status to make their own awards from level 6 to level 9 inclusive. Awards can only be conferred, granted or given on the recommendation of the HEI's academic council to or on persons who satisfy the academic council that they have attended or otherwise pursued or followed appropriate courses of study, instruction, research or training provided by the HEI (Law Reform Commission, 2019).

Designated awarding bodies should include their awards in the NFQ and co-operate and consult with QQI. Most Institutes of Technology's academic councils have adopted the QQI educational standards for all their programmes from 1st January 2020 (QQI, 2016). In addition, HEI's academic councils have developed quality assurance guidelines for programmatic review (LIT, 2020-2021).

The standards and guidelines for quality assurance (ESG) in the European Higher Education Area (EHEA) were adopted by the Ministers responsible for higher education in the EHEA in May 2015. The ESG applies to all higher education offered in the EHEA regardless of the mode of study or the place of delivery (ESG, 2015). These overarching systems link different countries' qualifications together and make qualifications easier to understand across different countries in Europe and beyond and assists the mobility of people. The ESG standard requires all higher education institutions to monitor and periodically review their programmes (known in the Institute of Technology sector in Ireland as programmatic review) to ensure that they achieve the objectives set for them and respond to the needs of students and society.

The following is an extract from section 3.3 of *QQI's Core Statutory Quality Assurance Guidelines* which defines programmatic review in the most general sense (QQI, 2016).

'Ongoing monitoring and periodic review of a programme is used as an opportunity to evaluate that programme with the benefit of the experience of programme delivery incorporating feedback from staff and learners. Such evidence is reflected in learner enrolment and programme completion rate data; learner, teacher, trainer, employer and/or industry feedback and evaluations of the programme. The information collected is analysed and the programme adapted to ensure it is up to date. Revised programme specifications are published'.

The HEI's Vice President Academic Affairs and Registrar has overall responsibility for overseeing the process on behalf of academic council and the Dean/Head of Faculty/School manages the process with the assistance of their Heads of Department and staff.

2.2.4 Accreditation Policy Documents and Standards for Engineering Education

Accreditation has been defined in section 1.2.5 of the introduction chapter. Historical evidence of engineering accreditation in Europe dates to 1934 in France, implemented by the La Commission des Titres de L'ingenier (CTI, 2006). The modern accreditation process began with the assistance of the USA Accreditation Board of Engineering and Technology (ABET) who later developed the *ECriteria 2000* which has become the global model for accreditation emulated by other countries (Patil & Codner, 2007).

The purpose of accreditation is to evaluate engineering education programmes against standards agreed upon and accepted by the international academic community and relevant industry stakeholders. Billings (1980a) defined standards as *'a programme is of acceptable standard if all students to whom its awards are granted achieve all of the programme aims and if those aims are appropriate to the level of the award'.*

Standards are more than the level of performance and includes the calibre and potential of the students at admission, the quality of the student's learning experience and the final level of achievement of the programme aims. In maintaining standards, this implies concern with the quality of the educational process, its environment and products. Quality of the process rests on the perceptions and judgements of staff, students and employers (Billing, 1980a).

In some countries, accreditation is conducted by a government organisation. In others, the quality assurance process is independent of government and is performed by private companies or professional associations (Aqlan, et al., 2010). In recent years the accreditation process measures either the competencies achieved by students or the evidence of the achievement of learning outcomes by students (Engineers Ireland, 2015), (SCSI, 2019), (RICS, 2019), (CIOB, 2018).

Engineers Ireland formally accredits all HEI engineering programmes in Ireland. Engineering education programmes which satisfy the appropriate criteria laid down in the *Accreditation Criteria for Professional Titles* document are deemed to meet the education standard required of individuals seeking one of the registered titles of Chartered Engineer, Associate Engineer and Engineering Technician (Engineers Ireland, 2014). Engineers Ireland have also published a supporting guidance document titled *Procedure for Accreditation of Engineering Education Programmes* (Engineers Ireland, 2015).

The broader European policies on the structure of higher education programmes influence the programmatic review and accreditation processes. The Bologna Declaration was published in 1999. Its overall objective is the establishment of a European area of higher education in which student mobility would be facilitated and enabled (EHEA, 1999). The Bologna Declaration states that higher education in Europe should be structured into two main cycles where access to the second cycle shall require successful completion of first cycle studies, lasting a minimum of three years. The second cycle should lead to the Master and/or Doctorate degree. The 3+2 model has become a standard reference in engineering. Integrated six/five-year master's degrees, 4+2 or 4+1 are also prevalent (Coyle, 2009).

2.2.5 Global Context Dependent and Dominant Cultural Influences

In the United States of America, ABET evaluates engineering education programmes and uses the *ECriteria 2000* as the basis of their participation in international multi-national accords and mutual recognition agreements. Patil and Codner (2007) have identified the challenges to be overcome by this accreditation policy implementation which include the ability to assess programme outcomes, workload and inconsistencies between evaluators.

In Europe, there are many policy developments including the Bologna Declaration (1999), standards and guidelines for quality assurance (ESG) and the establishment of FEANI and ENAEE.

ENAEE stemmed from ESOEPE and addresses specifically the education of engineers and promotes the quality of the education of engineering graduates. ENAEE authorises accreditation and quality assurance agencies to award the EUR-ACE label where an agency has satisfied the standards in the EUR-ACE Framework Standards and Guidelines (ENAEE, 2015). Since 2006, the EUR-ACE label has been awarded to more than 1800 engineering programmes, delivered in more than 300 HEIs in 28 countries in Europe and worldwide. ENAEE aims to build a pan-European framework for the accreditation of engineering education programmes and has created a common approach to accreditation and assists in simplifying different systems (ENAEE, 2020).

In the Asia – Pacific region, Australia and New Zealand have led the development of accreditation processes and were founder members of the Washington Accord. Currently, forty-one jurisdictions are members of the Washington Accord. The significant challenge of maintaining quality assurance processes where there is significant growth in engineering education is posing difficulties together with diversity, non-uniformity and lack of mutual collaboration (Patil & Codner, 2007). Engineers in international collaboration on projects must understand the cultural policy context including educational systems, ethics and political contexts (Zhu & Jesiek, 2014).

Ball (2012) is of the view that education policies are converging to produce a singular vision of the 'best practice'. This is particularly true of the Engineers Ireland accreditation policy which has been influenced by international policies and mutual recognition agreements. From the literature and the researcher's experience, there seems to be a race towards adopting a 'best practice' accreditation methodology, now commonly known as the *Washington Accord*. Countries not part of the agreements are seeking to reform their policies to allow them entrance to this exclusive group. This convergence in policy is also evidenced globally for the programmatic review process but has occurred in a more haphazard way over a longer period.

2.2.6 Policy Communities and other Policy Stakeholders

Education policy is being developed in new locations, on different scales by new policy communities that have global and national significance. Policy communities are an emergent group tasked with policy formation and implementation. These policy communities have created a new form of governance and have influenced the meaning and practice of education and bring into play new sources of authority (Ball, 2012).

Patil and Codner (2007) consider quality assurance processes in engineering education to be internal (university), external (professional association), national (national agencies) and international (international agencies). In engineering education, the internal policy community would exist within the HEI, such as academic council. The external policy community are the professional associations. The national policy agency could be QQI or the Higher Education Authority (HEA). The international agency could be ENAEE or the International Engineering Alliance (IEA).

Policy communities consist of professionals, policymakers and interest groups (Rhodes, 1997). Rizvi & Lingard (2010) contend that this has led to a polycentric state with private sector involvements and claim that policy communities sit across local, national and global entities and facilitates relations between national and global organisations.

Engineers Ireland in the formation and implementation of its accreditation policy has all the above characteristics of a national policy community who are linked to a global policy community through international accords and agreements and membership of the IEA and the World Federation of Engineering Organisations (WFEO). An important consortium of the accreditation of engineering education is the Washington Accord, initiated in 1989 by six countries. The objective is to recognise substantial equivalence of accreditation systems of engineering education programmes in signatory countries (ABET, 1989).

According to Patil & Codner (2007) other international mutual recognition agreements have been added to this policy ensemble, including *the Sydney Accord (2001),* the *Dublin Accord* (2002) and the *International Professional Engineer Agreement (IPEA) in 2008* (IEA, 2001), (IEA, 2002), (IEA, 2008). Engineers Ireland are a signatory to all these accords and agreements and participates actively in the processes of policy formation and implementation.

Policies are adapted by policy communities involving diverse participants, with a variety of commitments, purposes and influences, which are held together by subscription to a discursive group. Policy transfer nationally and globally is thus an emergent and multiple scaled process (Ball, 2012). Engineers Ireland and other professional associations have established Academy Groups within their organisations which advise government on engineering/construction matters. These think tanks have specific entries into political systems and are nested in a web of relationships (Ball, 2012).

Other engineering education policy stakeholders include the employers, students, graduates, other professional associations and government agencies.

Not all stakeholders are equally positioned to influence educational policy nor do those affected contribute to the policy process in the same way (O'Sullivan, 2005). The Central Statistics Office's 2011 census confirmed that 92% of engineers in Ireland were male (Central Statistics Office, 2012). Therefore, engineering education policies may be missing the female voice. Other relevant voices which should contribute to engineering education policy formation include educators, engineering practitioners and employers. These voices are more to the forefront, louder and more easily discernible and recognisable in the Engineers Ireland policy documents than in the QQI policy documents.

Policy formation by policy communities, where stakeholders are consulted and have an active voice in the processes, ensure easier implementation and interpretation of the policy. The open method of collaboration is a means of spreading best practice while achieving greater convergence towards common goals and may produce more effective and legitimate education policies (Livingston, 2003). The QQI policies are adopted and adapted by academic councils in each HEI but the interpretation of the policies is more contentious. The professional practitioner voices are missing from the policy formation stage, which contribute to the variety of interpretations of policy experienced at implementation stage.

Policy communities have influenced quality assurance in engineering education through the accreditation process. It is evident from analysis of the literature that the global success of the accreditation policy reflects the inputs of the stakeholders who contributed to its creation.

2.2.7 Gatekeeper Role

In engineering education quality assurance, there are two main powerbrokers, the state and the professional associations, acting as gatekeepers and controllers for the roll out of policy admission to the engineering profession. The state exerts its power and authority in quality assurance through the Department of Education and Skills (DES), the HEA and QQI policies and procedures. The professional associations exert their power through policies such as the Engineers Ireland *Accreditation Criteria for Professional Titles* policy.

Osborne (1996) suggests that we are moving towards an interventionist state where accountability is demanded. In tandem, during the last decade, the Engineers Ireland accreditation review has changed to a rigorous evidence-based measurement of student achievement of learning outcomes.

The professional associations have become an equal player in the quality assurance space. A significant factor in how the professional associations use their power is that all policies and implementation processes are managed through a collaborative process within their internal structures and especially their accreditation/education boards (Ball, 2012). The voice of employers and professional practitioners is captured in this collaborative process.

Power is equally dominant as the validation and accreditation processes are currently independent of each other and both play a gatekeeper role. It is possible to validate an engineering education programme but not be awarded Engineers Ireland accreditation for that programme. It is not possible to accredit a programme that is not validated. The programmatic review and accreditation policies have a gatekeeper function where admission to a professional elite is controlled by adherence to the policy measures. In recent times there has been as shift towards the accreditation policy as being the dominant policy to ensure the quality of engineering programmes in Ireland because of the evidence-based approach used to assess the programme content and the emergence of curriculum improvement as a result.

2.3 Engineering/Technological Education Development

Having established the origins, key characteristics, and national as well as global significance of engineering programme validation and accreditation, this stream follows the growth of engineering education from the 18th century to recent times. The discussion centres around education acts, special committee reports and national councils responsible for the quality assurance of engineering and technological education.

2.3.1 Overview

There are many examples of engineering construction and design historically and in modern times. This stream of the literature review will focus on engineering education rather than engineering practice. A brief outline of the development of engineering education in Europe and the United States will be mentioned but this stream will concentrate mainly on the British and Irish education systems. The Irish engineering education system set up similar structures to, and followed, the innovations pioneered in the British system. Many of the quality assurance policies, processes and procedures that we follow today were developed in the British education system initially, before being absorbed into the Irish education system.

2.3.2 First Shoots: 1747-1940s

The first moves towards the formal education of engineers began with the establishment in France of the '*Ecole de Ponts de Chaussées*' in 1747. Much of the learning was based on actual engineering projects. In 1795, the '*Ecole Polytechnique*' was established, a school dedicated to providing high intellectual and scientific formation to its students through a curriculum of prescribed programmes showing strong mathematical bias. Entrance was highly competitive via a common examination. Approximately one hundred students were admitted, and this remains the case today (Dooge, 2006). In 1829, the '*Ecole Centrale des Arts et Manufactures'* offered an education more inclined towards industrial practice.

One of the first engineering texts was '*Science for Engineers'* published in France in 1759. George Semple was an Irish engineer who published a book on the construction of the Essex bridge foundations in the 1750s which was one of the earliest civil engineering books written in the English language (O'Dwyer, 2019).

As early as 1796, some lectures on the principles of engineering were given in the University of Cambridge. In Britain in 1812, a special Royal Engineering School was set up in Chatham as a result of the experience of the peninsular war. For most of the 18th and well into the 19th century, the education and training of those responsible for the building of bridges and railroads, the improvement of the engines and machinery of the industrial revolution, were schooled by a system of *apprenticeship* and through *pupilage*. The aspiring engineer studied as an intern with a mentor, an already established and practicing engineer. Their internship lasted 3-4 years and could cost 1000 pounds (that is what Brunel charged) (Buchanan, 1986).

History shows that the genesis of engineering education in the United States of America commenced in 1817 when the director of the Military Academy at West Point used the Paris Ecole Polytechnique methodology as his model (Coyle, 2009). In 1823, Stephan Van Rensselaer and Amos Eaton set the groundwork for what was first called 'the Rensselaer School' in New York. This became, after a decade or so, a professional school of civil engineering (Wickenden, 1929). In 1946, B. Franklin Green reorganised the school into a comprehensive polytechnic providing technical education. According to Wickenden (1929), Greene founded his polytechnic on the technical schools of Paris. The Rensselaer Polytechnic Institute, under Green's direction, set the example for other schools (Union College, Dartmouth, Brown and the University of Michigan).

The University of Karlsruhe was formed as a 'Polytechnische Schule' in October 1825, having as example the Ecole Polytechnique in Paris. It was the first technical university or Technische Hochschule (TH) in Germany (Coyle, 2009).

In 1841, the first professor of civil engineering, Irish-born Charles Vignoles, was appointed in the University of London. In Ireland, the first professor of the practice of engineering, John Nc Neill, was appointed by Trinity College, Dublin in 1842 (Dooge, 2006). The engineering school in Trinity College was based on the Paris 'Ecole Polytechnique' (O'Dwyer, 2019).

Harvard and Yale started schools of applied science in 1847. According to Wickenden (1929), Harvard College did not offer technical studies which was a major factor contributing to the establishment of the Massachusetts Institute of Technology on an independent foundation in 1860. Yale established a three-year civil engineering programme in 1856 and a donation by J. E. Sheffield led to the establishment of mechanical engineering programmes. A significant boost to the education of engineers in the United States of America occurred in 1862 when the government passed the Morril Land Grant Act. Each state received a grant of federal land (121km^2) to be used to establish engineering educational institutions. Within a ten-year period, the number of engineering schools went from six to seventy. The end of the 19th century saw a move towards the emergence of science-based education (Coyle, 2009).

In the United Kingdom, by the end of the nineteenth century, the Institution of Civil Engineers was setting its own examinations for the qualified membership grade of the Institution. Other Institutions soon followed suit including the American Institutions. It was possible to obtain professional membership of the professional association without a university degree. University degree programmes had to be recognised for exemption from the professional association's examinations (Coyle, 2009). Heywood (2020) concurs and believes that the professional association's examinations were legally equivalent to a university degree at the time. These developments hinted at future tensions between universities and professional associations around responsibility for quality assurance and professional standards in engineering education.

In 1921, the UK Ministry for Education established a system of national certificates and diplomas. Students in technical colleges were able to undertake work of a high standard and professional associations provided a flexible system of examining. In 1957, only one-third of those admitted to professional membership of the UK engineering associations possessed university degrees, the remainder had alternative equivalent qualifications (Coyle, 2009).

2.3.3 Attempts to Remodel Secondary Education: The 1944 Butler Education Act in England and Wales

In 1930's Britain, there was movement for social reform because of the impact of the first world war and the financial crash of the late 1920s. There were reports, inquiries and legislation from that period that addressed education for changing times. The 1944 Butler Education Act was based on two reports under the chairmanships of Spens and Norwood.

In 1933, a Consultative Committee was set up to report on schools which provide education from pupils beyond the age of 11. The Spens Committee was chaired by Sir Will Spens which reported in 1938 (Board of Education, 1938). The committee were concerned with the development of the secondary level curriculum and concluded that there was no single or simple line of evolution but rather a series of sporadic attempts to relate school studies to the life of the times. All efforts to adjust the school curriculum to meet the ever-changing social environment were resisted. The study of language through Latin and Greek were emphasised (Ballard, 1939).

Engineering graduates who possessed an ordinary national certificate followed by a higher certificate with additional endorsements satisfied the educational requirements for Associate membership of a professional association. Under the Burnham salary scales which were introduced after the 1944 Act, persons who possessed Associate membership gained this way were accredited as having a general (ordinary) degree (Heywood, 2020).

Another contemporary inquiry into secondary education in the UK was chaired by Sir Cyril Norwood and reported in 1943 (Board of Education, 1943). The report of the Norwood Committee recommended that the structure of secondary education should be changed to include technical schools with parity of esteem. All schools should have the same curriculum up to age 13. The subjects were either in the arts/humanities or in mathematics and the sciences. British social hierarchy led to technical schools having less status than grammar schools. Secondary technical schools were established (200 of them) under the 1944 Butler Education Act but they never prospered (Board of Education, 1944). The Butler Education Act resulted in the formation of the *Committee on Higher Technological Education*.

Although the place of science in British universities had been established in the late 19th and early 20th centuries, the place of technology had not. The Second World War was the driving force of technological change which drove the demand for appropriately qualified personnel into the discussion about university curriculum development (Silver, 1990).

2.3.4 Creation of a Dual-Sector Approach to Engineering Education: The Percy Committee Report

The Percy Committee, chaired by Lord Eustace Percy, reported in 1945 on *Higher Technological Education* (Ministry of Education, 1945) and the following year the Barlow Committee reported on *Scientific Manpower* (Silver, 1990). The Percy Committee was established to consider industry requirements, needs of higher technological education and to find the means to collaborate between universities and technical colleges. Higher technological education had evolved into two sectors:

(i) Small university sector offering degrees in science and engineering;
(ii) Parallel sector of technical colleges where earn and learn was a major concern (Heywood, 2020).

In 1939, technical colleges produced more engineers than universities. The experience of world war two highlighted the shortage of trained scientists and technologists who could apply the results of research. The Percy report highlighted that technological training must be conceived in terms of a combined programme of works training and academic studies and that full cooperation between industrialists and educators was of supreme importance in initiating new branches of technology (Heywood, 2020).

The Percy Committee was anxious to raise the status of the engineering profession. In the report five categories of types of technologists were identified:

1. Senior administrators;
2. Engineering scientists and development engineers;
3. Engineer managers (design, manufacture, operation, sales);
4. Technical assistance and designer draughtsmen;
5. Draughtsmen, foremen and craftsmen (Ministry of Education, 1945).

The Percy report recognised that every technology is both a science and an art. Science includes the general principles which are valid for all applications which is learnt in universities. Art is the specialist application to problems learnt in formal works training in technical colleges. Therefore, the different styles of training in universities and technical colleges would lead to engineers with different qualities. University graduates would be Engineer Scientists and Development Engineers. Technical college graduates would be Engineer Managers (design, manufacture, operation, sales) (Silver, 1990).

The Institution of Electrical Engineering stated that 3,000 new graduate engineers would be needed every year for at least 10 years (civil, mechanical and electrical). Technical colleges should produce at least 1,500 of them (1,000 by the higher national certificate route and 500 by full-time study over substantial periods of time interwoven with planned phases of work practice) (Heywood, 2020). The work practice was later to become the practice of *sandwich* programmes in the UK and *cooperative* programmes in the USA.

According to Heywood (2020) the Percy Committee recommended:

- The establishment of seven colleges exclusive of the greater London area to develop *'technological programmes of a standard comparable with that of university degree programmes';*
- A diploma qualification, with the diploma considered the same level as a degree;
- Offer degree level programmes for graduates to meet the needs of industry;
- Change courses in technical colleges from part-time to full-time study over four years in which academic study was interspersed with periods of work experience;
- Technical colleges would teach the 'art' of technology based on a science foundation.

The expectation was that the technical colleges would become universities in time. What the Committee proposed was the creation of a National Council of Technology to be responsible for the awards and standards in the colleges. Neither the Percy Committee, nor the Barlow Committee (which went in a similar direction), envisaged that the new award would be a degree, but the new awards would be parallel or equivalent to university degrees. The status of a diploma award being equal to a degree award was never realised due to the prevailing British culture at the time. Sir John Cockroft argued that '*we ought to get rid of the once strongly held feeling that education for technology is a lower form of education than education in the arts'* (Cockroft, 1952).

2.3.5 Formal Recognition for Technical Colleges: The National Council for Technological Awards (NCTA)

The Minister of Education announced the establishment of the National Council for Technological Awards (NCTA), on the recommendation of the Percy Committee, in 1955 under the chairmanship of Lord Hives (Heywood, 2020). The NCTA was operational under the framework of a government White Paper on *Technical Education* in 1956. The role of the NCTA was to create and administer awards for students in technical colleges.

The Minister constituted for the NCTA a Governing Body, a Board of Studies in Engineering and a Board of Studies in Technologies other than Engineering. The Boards of Studies duties included:

- Consideration of the curricula, standard of the work and syllabi of the science and technology programmes proposed by the technical colleges;
- Consideration of the standard of admission to said proposed programmes;
- Consideration of the qualifications of the teachers;
- Consideration of the facilities and equipment available for the proposed programmes;
- Consideration of the principal conditions of the conduct of examinations including the approval of external examiners.
  (Ministry of Education, 1956a).

The essential role of the NCTA was to provide qualifications in engineering and technology for students in technical colleges on undergraduate programmes. The colleges were to plan their own programmes and examinations. The NCTA board was not to be an examining body but a *recognising body*. The new undergraduate award was to be a Diploma in Technology (DipTech). One of the main differences between the diplomas in technology and university degrees was the integration of the college programme with industrial experience. In 1959, the NCTA established a higher award than the DipTech called Membership of the College of Technologists (MCT) which was divisive and not welcomed (Silver, 1990).

The NCTA strongly endorsed the principle of alternating and relating college and industrial experience with '*an aggregate of at least one year of industrial training in addition to academic study'* (National Council of Technological Awards, 1956). A variety of different sandwich programmes evolved principally variations on 'thin' (alternating period of six months in college and six months in industry) and 'thick' (normally the third year in industry) arrangements for the four-year programme (Silver, 1990).

By the time the White Paper on *Technical Education* was issued in 1956, there were twenty-four technical colleges and part-time advanced programmes in 150 or so local colleges. Between 1956 and 1960 one hundred programmes had been recognised by the NCTA in twenty-three colleges (Ministry of Education, 1956a). The White Paper set out to describe the government's intention to improve and expand technical education opportunities and facilities.

A four-tier system was envisaged ranked in order of level of work and extent of study:

1. Colleges of Advanced Technology (CAT's) – Full-time education of technologists
2. Regional Colleges – full-time and part-time education of technologists and technicians
3. Area Colleges – technician training
4. Local Colleges – Part-time for craftsmen and operatives (Heywood, 2020).

The White Paper defined Technologists and Technicians**.** The definitions were taken from the Conference of Engineering Societies of Western Europe and the USA (EUSEC) in 1953 as definitions of Professional Engineers and Technicians and later published in 1961 (EUSEC, 1961). It was not thought that women should become engineers.

The intention was to promote the development of a small number of Colleges of Advanced Technology (CATs) in England and Wales and to improve Scotland's existing Central Institutions. CATs were to be those institutions engaged exclusively in work at advanced level whether in full-time, part-time or sandwich programmes. Ten CATs were established (seven in the provinces and three in London) and it was intended that they should stand beside the universities as fully effective partners (Silver, 1990).

In the case of professional associations, the NCTA met with ready acceptance from all but the Institution of Mechanical Engineers, which insisted that in the early stages the Institution had to lay down ten conditions in order to satisfy itself of the college's standards. The ten conditions were to allow the Institution to accept the DipTech in Mechanical Engineering awardees for exemption from its own examinations. By 1959, the ten conditions had reduced to two conditions and then phased out. There were no such problems with other engineering professional associations (National Council for Technological Awards, 1961).

The number of science and technology students graduating in 1956 was just over 6,000 of whom 4200 were is pure science and 1850 in technology. By 1963-64 the NCTA had approaching 9,000 students attending 122 programmes leading to the Diploma in Technology and had conferred over 3,000 Diplomas since in first conferment in 1958 (Silver, 1990).

Until the 1960s, higher education meant the Universities. Not until the appointment of the Robbins Committee in December 1960 '*to review the pattern of full-time higher education in Great Britain'* did a conception of higher education embracing sectors other than the Universities become widespread currency (Silver, 1990).

New universities were already being created at the beginning of the 1960s including the Open University. Curriculum changes were taking place for all programmes in the CATs, new universities and established universities. The Robbins Committee report recommended that CATs become technological universities, conferring their own degrees and a new system for degrees should be established covering business studies, languages and other subjects as well as science and technology (Ministry of Education, 1963).

The role and functions of universities were debated between 1940 and 1960. The meaning of, and place of, the ‘professional’ in the university was considered at various stages. The Nuffield Group considered that a university, while maintaining a reasonable range of studies, should not allow itself to be turned into a specialised institution serving the needs of one profession or one field of research (Nuffield College, 1948).

The Robbins Committee report also recommended that a Council for National Academic Awards (CNAA) be established to replace the NCTA and to cover areas of study outside the fields of science and engineering. The British government created a dual system of higher education that remained in place until 1992. There was competition between the CATs and universities for resources. From an educational perspective technology was viewed as a second-class citizen (Heywood, 2020).

2.3.6 Raising Standards through Programme Validation: The Council for National Academic Awards

The government followed the publication of the Robbins Committee Report with the establishment of the Council for National Academic Awards (CNAA). The CNAA was to award degrees at comparable standard to those of the universities and widen the range of subjects available beyond science and technology. The CNAA was to raise standards in extra mural institutions, some of which might ultimately become universities (Church, 1983).

2.3.6.1 Raising and Enhancing Standards in Programmes Outside the University Sector

The Ministry of Education proposed membership of the CNAA to be university and CAT members, those from colleges associated with the CNAA’s awards and members from industry, commerce and local government (Silver, 1990). The primary role of the CNAA’s Boards of Studies would be to approve programmes in HEIs outside the university sector.

The CNAA would be able to confer degrees, diplomas, certificates and other academic awards and distinctions, grant degrees to holders of the DipTech, MCT or an Associateship of a Central Institution in Scotland, confer research degrees or honorary award degrees (Silver, 1990). The CNAA scrutiny of all degree programmes was seen as a guarantee that they were academically sound, thoroughly prepared and of a comparable standard to university degree programmes (Gold, 1979).

The CNAA endorsed the activities of institutions, approved programmes in new subject areas and established a framework and atmosphere in which policy could be determined. The Council had only a handful of officers at this stage to service its pyramidal structure in which boards reported to committees and committees reported to the Council. In its first annual report, the CNAA reported that 18 subject boards had been established and decisions on 67 programme proposals had taken place (Silver, 1990).

The new universities of the 1960s and CATs were given university status and had Academic Advisory Committees to provide guidance towards appropriate programme development. In many countries expansion of higher education was through the expansion of the existing institutions and sectors, or the creation of new sectors, or both. In the USA in the 1960s this meant the expansion of existing institutions but also the creation of state universities with moves towards greater state-wide coordination and control. In Australia, it was to mean the creation of a sector of Colleges of Advanced Education. In Europe, the process was widespread. In the Federal German Republic, the Fachhochschulen were reclassified as higher education at the end of the 1960s. France created the Instituts Universitaires de Technologie, while other countries redesigned their higher education to incorporate teacher and technical education under new names or with new roles and relationships (Silver, 1990).

The government decided to concentrate a good deal of advanced work in a new generation of *polytechnics*. The policy for polytechnics was announced in the government White Paper in 1966 and finalised in a Parliamentary Statement in April 1967 when 28 polytechnics for England and Wales were confirmed, leaving open the possibility of two more (Secretary of State for Education, 1967). Guidance notes for the creation of polytechnics were provided with the White Paper and Parliamentary Statement which declared that '*institutions can be developed as comprehensive academic communities offering a wide range of disciplines and catering for full-time, sandwich and part-time students at all levels of higher education'* (Council for National Academic Awards, 1967).

The 1966 White Paper made it clear that the polytechnics should not have a monopoly of higher education in the public sector, but they were to have priority in resource allocation. The procedure for approving programmes before submission to the CNAA for approval was administered by Her Majesty's Inspectorate (HMI) through the Regional Advisory Councils, and this procedure was operated in favour of the polytechnics (Silver, 1990).

The universities now had to share the apex of the educational system with the polytechnics and the CNAA. It was the binary policy that influenced the CNAA's operations for the next two decades (Silver, 1990). Into the early 1970s the programmes proposed to, and validated by, the CNAA were predominantly in science and technology (Silver, 1990). By September 1968, three-quarters of students were registered on science and technology programmes. By this stage the CNAA Committee for Science and Technology had twelve subject boards and was approving programmes in new subject and interdisciplinary areas including for the first time instrumentation and control engineering and computer systems engineering (Council for National Academic Awards, 1968). Within the Committee for Science and Technology and its subject boards the commitment to sandwich programmes remained strong (Silver, 1990).

The CNAA's purpose remained to validate degrees and other awards in institutions other than universities, whether or not they were designated as polytechnics (Silver, 1990). The CNAA's validation procedures were designed to be rigorous. It remained difficult to obtain CNAA approval for programmes at first submission. The rigorous element of the approval process made it frequently a long one and was often accompanied by rejection. CNAA validation unified and differentiated the public sector as a means of quality control. Validation would become an all absorbing operation. Concern about '*administrative overload'* led to the imposition of new layers of activity which made internal planning and management of HEIs more difficult than before (Church, 1983).

2.3.6.2 Towards Internal Validation

By 1970, the CNAA developed a keen interest in the role of the HEI's academic board. The CNAA were seeking that there was evidence of an academic machinery that could exercise responsibility for the continuing scrutiny of programmes (Silver, 1990). The CNAA would remain the final authority but academic boards in experienced institutions could be authorised to reach decisions in defined areas, decisions to be reported to the CNAA and normally accepted (Silver, 1990).

Engineering was at the time underrepresented and low priority in the universities. According to Silver (1990) there were 1703 programmes approved by the CNAA with a total of 123,229 registered full-time students (of which 35,000 were on sandwich programmes) and 13,000 part-time students in first degree programmes by 1980-1981 as illustrated in Table 2.1. At the time the CNAA was the largest degree awarding body in the United Kingdom (Clapham, 1976). There were still tremendously varied employer perceptions of the quality and employability of polytechnic graduates (Boys, 1984).

Discipline Field	Number of Registered Students
Science and Engineering/Technology	45,759
Arts and Social Studies	33,274
Art and Design	15,361
Business and Management	12,782
Education	12,911
Interdisciplinary Programmes	3,142

Table 2.1: CNAA Registered Students in 1980-1981 (Silver, 1990)

The CNAA had acquired in the 1970s a complex pattern of relationships with Institutions whose academic and administrative shapes were vastly different, and whose political, financial and planning relationships with other bodies were equally different (Silver, 1990). In 1979, the CNAA extended its work to Hong Kong. Other countries, including Ireland and Australia had shown interest in the CNAA’s form of operation (Silver, 1990).

By 1975, the CNAA were pursing the idea of internal validation. *Partnership in Validation* was published in July 1975 (Council for National Academic Awards, 1975). Further development of the concept of partnership was published in September 1979 titled *Developments in Partnership in Validation* (Council for National Academic Awards, 1979).

The CNAA recommended in 1983 that *joint validation* should be adopted as the established form of relationship between the CNAA’s subject boards and the polytechnics for programme validation and review. Joint validation requires the polytechnic to be responsible for the *internal validation* and the final stage of the procedure to be a joint exercise with the CNAA. The CNAA need only carry out regular institutional review to evaluate the institutions procedures *which they called Accreditation of the Institutions* (Silver, 1990).

2.3.6.3 Emergence of Engineering as a Distinct Discipline

One of the CNAA's most active concerns in this period was its evidence and response to the *Finniston Committee of Enquiry into the Engineering Profession which produced the report on Engineering our Future* in 1980. This influential report made recommendations relating to qualifications, registration and licencing of engineers and national arrangements for promoting and strengthening what is described as *the engineering dimension* in the British economy (Committee of Inquiry into the Engineering Profession, 1980). The CNAA in response welcomed the emphasis in the report on design, problem solving and the creation of bridges between the formation of engineers and engineering practice in the proposed new degree of B.Eng. (Council for National Academic Awards, 1980).

From 1980 and for several years the CNAA devoted considerable energy to the formation of engineers (Silver, 1990). It expressed the view that the Finniston Report had created an opportunity '*which is unlikely to occur in the foreseeable future to improve the profession of engineering'*, and it set out the framework in which the CNAA would validate BEng programmes (Council for National Academic Awards, 1982). Engineering, as the Finniston Report itself had strongly underlined was not, as was commonly and mistakenly assumed, a subordinate branch of science. The CNAA saw engineering as a '*discipline distinct from science'* (Silver, 1990). The CNAA spelled out its understanding of the future shape of engineering education:

'*The direction of a student's engineering studies must be towards greater understanding and competence, and effective communication. He must be encouraged to develop the ability to see relationships, to synthesise and to appreciate modes of thought, attitudes and practices other than those of his main discipline…… Because of the nature of the engineering profession, an engineering degree programme should provide a technically broad education, particularly in the early stages'* (Council for National Academic Awards, 1983).

The CNAA were in the forefront of the development of the B.Eng. of '*engineering applications*' and the bridging of programmes and industrial experience. The CNAA co-funded research based at Leicester Polytechnic on '*The goals of engineering education'* and in 1985 it was one of the sponsors of a conference on '*What makes a B.Eng. programme'* (Reid & Farrar, 1985). It consulted with the Technician Education Council (TEC) and the Engineering Council (ECUK) on the variety and level of engineering awards. This was an example of the CNAA's capacity to lead in an area of the curriculum (Silver, 1990).

2.3.6.4 Changing the Relationship with Institutions

In 1984, the Secretary of State for Education and Science appointed a Committee of Inquiry (Chaired by Sir Norman Lindop). The Lindop Committee reported in 1985 and welcomed the detailed examination of programme proposals by the CNAA and criticised the Universities whose validating procedures were not demanding enough (Committee of Enquiry, 1985).

The Department for Education and Science issued a Green Paper on *The Development of Higher Education into the 1990s* in May 1985 (Secretary of State for Higher Education and Science, 1985). The main thrust was towards technological and vocational programmes and bringing higher education closer to industry, commerce and the public sector.

In October 1986 the CNAA issued a consultative document on *Quality and Validation: Future Relationships with Institutions.* Accreditation would mean that the institutions would have full responsibility for the approval and review of taught programmes. To be accredited an institution would have to demonstrate that its academic board had effective arrangements in place for validation and the periodic review of programmes. Non-accredited institutions would continue to submit programmes for validation by the CNAA which would seek to work jointly with the Institutions (Council for National Academic Awards, 1986).

The CNAA issued a consultative document *Future Strategy: Principles and Operation* in February 1987. The proposal that all institutions should review all their programmes every 5 to 7 years was retained (Council for National Academic Awards, 1987). The 1987 Supplemental Charter empowered the CNAA to adopt an '*Instrument of Accreditation'* where a HEI would be permitted to approve programmes leading to the award of degree, certificate and diploma (Council for National Academic Awards, 1988).

The CNAA's Committee for Engineering had seen through the conversion of the majority of the CNAA's engineering programmes to B.Eng. and in 1987-88 adopted revised guidelines for degrees in engineering, including the provision of a '*double award'* of BEng/MEng for students following MEng programmes. It was approving an increasing number of engineering degree programmes, particularly in electrical and manufacturing engineering. In 1987-88 the CNAA's Committee for Engineering found itself responsible for more programmes than any other subject board (Council for National Academic Awards, 1988)**.** In 1987-88 almost a quarter of a million students were registered for CNAA awards (see Table 2.2) with approximately 42% of the students on programmes in science and technology (Silver, 1990).

Academic Year	No. of Students Enrolled on CNAA Programmes	No. of Programmes leading to CNAA Awards
1965-66	4,000	89
1968-69	15,547	213
1976-77	80,000	1000
1980-81	135,000	1703
1987-88	224,000	1725

Table 2.2: CNAA Award Registrations 1965-1988 (Silver, 1990)

The government published a White Paper on *Higher Education: Meeting the Challenge* in 1987 and an *Education Reform Act* in 1988 (Secretary for State for Education and Science, 1987). Twenty-nine polytechnics and twenty-eight other HEIs were transferred out of local authority control and given corporate status on 1st April 1989.

The impact of the CNAA on the British higher education has, for over a quarter of a century, been in terms of its sustained concern with the enhancement of standards. By the end of the 1980s ninety percent of students in the polytechnics and colleges sector would be in *accredited* institutions and 85 or so institutions would remain as *associated* institutions (Silver, 1990). The CNAA was operating until 1992 and dissolved by the UK *Further and Higher Education Act 1992*. The British government asked the Open University to continue the work of awarding degrees in non-university institutions (The Open University, 2020).

2.3.6.5 New Arrangements for Programme Validation in Higher Education in the UK

The Open University Validation Partnership (OUVP) was established in 1992 to enable the open university to validate programmes for HEIs who do not have their own degree awarding powers. Currently, an education provider without degree awarding powers that wishes to offer higher education programmes must have a validation agreement with a degree awarding body. The Open University has a network of 40 partner institutions worldwide and validates 390 undergraduate and postgraduate programmes from foundation degrees to PhDs in a wide range of disciplines (The Open University, 2020).

The Higher Education Quality Council (HEQC) was established in May 1992 following *the Further and Higher Education Act*. The remit of the HEQC was to contribute to the improvement of the quality of higher education in the UK. The HEQC carried out regular audits and produced good practice guidelines (The National Archives, 2020).

The Quality Assurance Agency for Higher Education (QAA) was established in 1997 through the transfer of functions and staff from the former HEQC. The QAA is an independent body entrusted with monitoring, safeguarding and advising on standards and quality in UK higher education wherever it is delivered around the world. The QAA's main areas of work include reviewing higher education, access to higher education, the UK quality code and advising students to ensure consistency of approach across the UK. The QAA works with sector partners to protect academic integrity (The Quality Assurance Agency, 2020).

2.3.7 Programme Validation in Ireland's Non-University Sector: The National Council for Educational Awards (NCEA)

The UK CNAA is the nearest equivalent to the National Council for Educational Awards (NCEA) in the Irish Republic (National Council for Educational Awards, 1975). The NCEA was a statutory body that was required to see that non-university HEI degrees were comparable to those in universities (Church, 1983). The National Council for Educational Awards was established in 1972. Prior to 1972, higher education was only available in the universities in Ireland. With the establishment of the regional technical colleges in 1972, higher education was available on a regional basis (O'Conchobhair, 1974).

According to O'Conchobhair (1974), Secretary of the Department of Education, many industries were dependent on highly qualified, highly specialised technical personnel. Despite the developments in technical education there was still a grave shortage of skilled craftsmen and highly qualified technicians. Due to the expansion of the technical education system, the proportion of third level technical teachers in the education system was low. As in the UK educational system, females were not considered suitable candidates for technical education.

As defined by the Minister of Education, the general functions of the NCEA was to promote, facilitate, encourage, co-ordinate and develop technical, industrial, commercial, technological, professional and scientific education and in association with these, liberal education in Ireland (National Council for Educational Awards, 1974). The NCEA executed this function by granting recognition to educational institutions, by approving their programmes of study, by making awards to students who are successful in examinations, by the organisation of conferences and seminars, the commissioning of studies on key problems in the third level non-university sector of education and by the issue of publications on matters of particular interest or importance (National Council for Educational Awards, 1974).

According to the Chairman of the NCEA in 1974, the NCEA saw its chief function was to provide a framework which would give considerable scope to individual HEIs and their departments to devise and develop their own programmes, to admit their own students, to plan and implement their own teaching programmes and in association with external examiners to examine them in whatever way was the most appropriate (Nagle, 1974).

The NCEA's basic function was to validate higher education programmes and it did this by considering what was presented to it in written submissions, what was learned by one or more visits to the HEI and what was reported by the external examiners. The NCEA wished the primary development of the curriculum to rest with the HEIs and their staff (Nagle, 1974).

The NCEA consisted of a Chairman and twenty-four other members appointed by the Minister for Education and broadly reflected the academic, professional and business life of the country and included people from the university and non-university sectors of education, industry, agriculture and public administration as well as two student members. The NCEA had four Boards of Studies of up to about 20 members each, one of which was for Engineering and Construction Studies. The Boards had powers to appoint expert panels**,** including persons from outside the NCEA to assist them in carrying out assessments of specific programmes or groups of programmes (Nagle, 1974).

The NCEA combined the validation role with an attempt to co-ordinate Irish higher education (Church, 1983). The NCEA programme validation procedure required the HEIs to make a detailed submission about the programme as set out in the NCEA guidance document. When the submission was received by the NCEA, it was assigned to the appropriate Board of Studies. The Board of Studies approved the site visit and established the site visit panel of programme assessors. Preparation of submissions to the NCEA was a laborious job for HEIs but was seen as a great step forward in the process of development of programme curricula (Nagle, 1974)**.** The NCEA conducted their visits similar to the CNAA site visits. As panel membership varied, cross institutional comparisons were difficult to generate (Church, 1983).

In 1974 the NCEA had 120 programme submissions; 10 for degrees, 30 for diplomas and 80 for certificate awards. The NCEA required all programmes to make another submission after some years because of rapid technological change. It was necessary to incorporate new knowledge and the latest techniques and to remove material from a programme syllabus that had become outdated. Those were the main reasons why the NCEA facilitated regular reviews of programmes (Nagle, 1974).

The proceedings, recommendations and decisions of a number of international agencies, such as the European Community, OECD, UNESCO and the Council of Europe had a significant bearing on the functions and work of the NCEA who kept in touch with relevant developments (National Council for Educational Awards, 1974).

The NCEA was put on a statutory footing in 1980 by the *National Council for Educational Awards Act* 1979 and remained the awarding body for the non-university sector until 2001 (Education, 2020).

2.3.8 Towards Qualifications Frameworks and Standards in Ireland's HEIs: The Higher Education and Training Awards Council (HETAC)

The Higher Education and Training Awards Council (HETAC), the legal successors to the NCEA, granted higher education awards in Ireland beyond the university system from 2001 to 2012. HETAC was created by *the Qualifications (Education and Training) Act 1999*, was subject to the National Qualifications Authority of Ireland (NQAI), and specifically, granted qualifications to many Institutes of Technology and other non-university HEIs. HETAC could delegate authority to Institutes of Technology to make awards. HETAC established policies and criteria for the making of awards, validated all programmes in higher education and set standards of knowledge, skill and competence which must be acquired by learners before an award could be made (Education, 2020).

NQAI was also established by the 1999 Act and was responsible for creating and maintaining the National Framework of Qualifications (NFQ), establishing procedures for HETAC and deciding on procedures to be implemented by the HEIs in relation to access, transfer and progression. The qualifications recognition service included the recognition of foreign qualifications and the international qualifications database (Citizens Information, 2020).

In 2004, HETAC completed the transition from awards derived from the NCEA standards to a new awards system based on the NFQ. In October 2008, the Irish government announced its intention to amalgamate HETAC, NQAI and two other bodies established under the 1999 Act whilst also incorporating the functions of the Irish Universities Quality Board (IUQB). The Minister of Education appointed an interim board for the new agency until its establishment in 2012. HETAC was dissolved and its functions were passed to Quality and Qualifications Ireland (QQI) in November 2012 (Education, 2020).

2.3.9 Quality and Qualifications Ireland (QQI)

QQI was established on 6 November 2012 under *the Qualifications and Quality Assurance (Education and Training) Act 2012.* QQI are responsible for delivering awards and standards, validating education and training programmes, reviewing providers of education and training, maintaining the NFQ, authorising the International Education Mark (IEM), developing quality assurance and facilitating qualifications recognition (Citizens Information, 2020). QQI endeavours to create a vision of Ireland that offers extensive and high-quality education and training opportunities, enabling learners to fulfil their potential through achieving qualifications that are widely valued nationally and internationally. QQI also advises the Minister for Education and Skills about national policy on quality assurance and improvement in education and training (QQI, 2020).

One of QQI's most important functions is to ensure that the quality assurance procedures of HEIs are effective. A key component is QQI's approach is undertaking external reviews of HEI's quality assurance on a cyclical basis. The first round of QQI's Cinnte Review cycles is taking place between 2017 and 2023 for all higher education providers (QQI, 2020). Monitoring is an external quality assurance process of evaluation and analysis of HEI's activities which supports public confidence in education and training. *The Annual Quality Report* is submitted by HEIs to QQI on an annual basis and provide details of their internal quality assurance processes and procedures (QQI, 2020). These comprehensive reports include all details of quality assurance policies, procedures, validation events and accreditation interactions with professional associations. QQI also engages in dialogue meetings with each HEI, on an annual basis.

This stream of the chapter depicts the development of technological and engineering higher education, and their quality assurance procedures, in the UK and Ireland from the mid-eighteenth century to present day. The second world war was the main driver for the establishment of engineering education supported by the Butler Education Act, the Percy Committee Report, the Robbins Committee Report and the Finniston Committee Report. The NCTA was the forerunner of the CNAA in Britain and collectively they established the engineering programme validation procedures, the fundamentals of which are still in place today for the programmatic review procedure. The Irish NCEA and HETAC closely followed the procedures set out by the CNAA for programme validation and these quality assurance processes are managed today by their successors QQI, QAA and the Open University.

2.4 Programmatic Review and Curriculum Development in Engineering Education

This stream outlines the HEI quality assurance and programmatic review processes. Historical engineering education curriculum development in terms of learning outcomes is summarised. The main features and contribution of the AHELO conceptual framework of expected learning outcomes in engineering, the ASEE attributes of a global engineer and the IEA graduate attributes and professional competencies are provided and their impact on engineering programme design is outlined.

2.4.1 HEI Quality Assurance and Programmatic Review

Irish HEIs are committed to the continuous improvement and enhancement of quality assurance systems, evidenced by new and revised quality assurance policies and procedures, adherence to the standards and guidelines for quality assurance in the European Higher Education Area (ESG, 2015) and the QQI guidelines (QQI, 2018).

Various factors that impact at national and regional level have an impact on quality delivery across HEIs including the reshaping of the higher education landscape, national reports and strategies and policy developments by QQI and the HEA (QQI, 2018). These developments have led to the expansion of influence of HEIs' Quality offices in terms of programme portfolio management, programme approval, programmatic review and staff development.

External authentication of HEI's quality assurance effectiveness and impact includes feedback from peer review panels, student surveys and external examiners. The composition of review panels and outcomes in the panel reports are not always consistent, despite the existence of guidelines for these processes. Quality enhancement is normally exercised through the continuous improvement of academic council policies and procedures and changes made in light of external examiner reports.

Programmatic review is a cyclical mandatory quality review process under the European standards and guidelines and the Qualifications and Quality Assurance Acts of 2012 and 2019. The HEI's programmes are comprehensively assessed for their fitness for purpose. The programmatic review is an opportunity for programme teams to fundamentally re-appraise programmes to make major modifications where considered appropriate. All programmes within a department will be presented during the periodic review process (LIT, 2020-2021).

In the context of a programmatic review, a programme may be modified significantly such as including new minor awards, new embedded awards, new electives or new modes of delivery and assessment. Programmes and modules may be updated or discontinued as part of this process. All programmes within a department are reviewed at the same time irrespective of whether or not the original validation period has expired for all the programmes. This includes the new generation apprenticeships. Substantial change to programmes should normally only occur at the time of programmatic review (Kyne, 2020).

2.4.2 The Programmatic Review Process

The main steps in the programmatic review process are outlined in this section and include the preparation of the self-evaluation documentation, the internal preparative review event and the response to the preparative panel report, the selection of the panel members and agenda for the programmatic review event, the programmatic review site visit and the programme team's response to the panel report, the department's implementation plan and academic council approval.

The department undertakes a self-evaluation process for each of its programmes. In preparing the self-evaluation, the programme team (comprising of academics who teach the programme) consults with current students, graduates of the programme, industry, business and other external organisations. Self-evaluation includes an assessment of the teaching processes and the contribution of research to learning. Each programme team documents its proposals for the future. The existing and proposed programme schedules are presented together with the reasons for the changes explained per module. The self-evaluation report is presented to the internal preparative review panel. Recommendations from the preparative review panel are considered by the programme team. A response to the report and a final draft of the self-evaluation report is then prepared (Kyne, 2020).

The Vice President Academic Affairs and Registrar, in consultation with the Dean of Faculty, selects a panel of external expert peers to conduct an evaluation of the documentation on behalf of the faculty/department. This panel includes discipline experts from other institutes of technology, from the university sector and from the relevant industry. The external programmatic review panel receives the self-evaluation report and supporting documentation well in advance of the site visit (Kyne, 2020).

During the site visit the panel examines the self-evaluation report in a constructive and supportive dialogue with faculty management, staff, students and other stakeholders and reviews the relevant teaching, laboratory, workshop and other facilities of the HEI. The programmatic review panel considers the proposed programme changes and present its findings at the end of the visit. A written report is prepared and makes recommendations for improvement and/or changes, based on a combination of the self-evaluation report, site visit and meetings with stakeholders. The panel report includes conditions and recommendations in respect of the continuing validation of the programmes. The department checks the report for accuracy before it is finalised (Kyne, 2020). The panel's report and the faculty/department's response are considered by academic council. The relevant changes are made to all modules and programmes and copies of the final documents are sent to the HEI Registrar's office. On ratification by the academic council, these documents are published on the HEI's website (Kyne, 2020).

2.4.3 Historical Context of Engineering Education Curriculum Development

Much of the impetus for engineering education curriculum development since the 1950s was driven by the professional associations and the programme validating bodies (NCEA, HETAC and QQI). Engineering curriculum development occurred as a consequence of both the internal programmatic review process and the external accreditation process. The last half of the twentieth century saw funding for scientific research on campus grow exponentially which resulted in engineering science being adopted as the core of engineering education but to the de-emphasis of the relevance of industrial practice. Some faculties changed their title to *Engineering Science* from *Engineering* (Coyle, 2009).

In the 1970s educationalists focused on the achievement of programme aims and objectives by students (National Council for Educational Awards, 1974). According to Heywood (2020), 'management by objectives' was popular in the late 1980s and early 1990s and this led to 'outcomes by objectives' and ultimately to learning outcomes and programme outcomes at the turn of the century. Student achievement of competencies was also popular.

The OECD (2011) defined learning outcomes as *'Statements of what a learner is expected to know, understand and/or be able to demonstrate after completion of a process of learning.'* Learning outcomes are expressed in terms of a level of competence to be attained by the learner and were related to student workload.

Competencies are defined as '*Competencies represent a dynamic combination of cognitive and meta-cognitive skills, knowledge and understanding, interpersonal and intellectual skills, practical skills and ethical values*' (OECD, 2011). This definition is in line with the international ISO 9000 norm which defines competencies as *'demonstrated ability to apply knowledge and skills.'* Some competencies are subject area specific (to a field of study); others are generic (common to any degree programme) (OECD, 2011).

Learning outcomes and competencies make study programmes comparable, compatible and transparent and are used to assess programmes in the programmatic review and validation processes.

2.4.4 AHELO Conceptual Framework of Expected Learning Outcomes in Engineering

The OECD organised several consultation processes with employers, graduates, academic faculty and students in different parts of the world to identify the most important competencies that should be developed in engineering degree programmes in 2008. The OECD, at the invitation of the Assessment of Higher Education Learning Outcomes (AHELO) group of national experts, contacted the Tuning Association to undertake development work on learning outcomes to be used for valid and reliable assessments of students from diverse institutions and countries. Engineering was selected for this study. Members of the engineering Tuning-AHELO working group defined engineering programmes, supplemented by branch specifications for the fields of mechanical, electrical and civil engineering, taking into account different degree profiles and relevant occupations (OECD, 2011).

Tuning is a university driven initiative to create points of reference, convergence and common understanding. The '*Tuning approach'* consists of a methodology to (re-)design, implement and evaluate study programmes for each of the Bologna cycles and is accepted by over 94 academic communities in 57 countries throughout the world (OECD, 2011).

The Bologna Declaration makes no reference to learning outcomes. At the Berlin Bologna Follow-Up Conference in 2003, Ministers indicated that degrees should be described in terms of workload, level, learning outcomes, competencies and profile. In 2006, a '*European Qualifications Framework'* was adopted which is compatible with the Tuning approach (OECD, 2011).

The Tuning AHELO expert group for the engineering strand decided to synthesise the learning outcomes used by ENAEE and ABET for the commonly agreed learning outcomes as both are recognised internationally amongst the most important engineering countries. Both sets of learning outcomes were highly compatible (OECD, 2011). The study group also checked the learning outcomes of the German Accreditation Agency and the UK SPEC.

The Agreed Framework of Learning outcomes are set out under five categories of learning outcomes needed to practice engineering: generic skills, basic and engineering sciences, engineering analyses, engineering design and engineering practice. These learning outcomes foster professional mobility within the 34 OECD countries. Specific learning outcomes were also agreed for civil, mechanical and electrical engineering. The concept of learning outcomes within the field of engineering has proven to be well established and welcomed by most stakeholders (OECD, 2011).

2.4.5 The ASEE Attributes of a Global Engineer

The American Society for Engineering Education (ASEE) established a stakeholder process in 2008 to identify and define competencies and characteristics needed by engineers in order to effectively live and work in a global context. The aim was to further define learning outcomes per attribute and to determine where in an engineer's educational preparation the attributes need to be introduced, reinforced and assessed.

The attributes that emerged are categorised into nine streams of engineering science fundamentals, understanding of engineering design, products and processes, context within which engineering is practiced, communication, teamwork, leadership, flexibility, curiosity and desire to learn and ethical standards and professionalism (Hundley & Brown, 2013).

In addition, twenty competencies associated with the attributes of a global engineer emerged. The main attributes expected upon graduation from a university and the top attributes by importance were identified and these are captured in Table 2.3.

Top Attributes by Importance	*Attribute Expected Upon Graduation*
Communicates effectively	Communicates effectively
Possesses the ability to think critically and creatively	Possesses the ability to think critically and creatively
Shows initiative and a willingness to learn	Shows initiative and a willingness to learn
Functions effectively on a team	Demonstrates an understanding of IT and digital competency
Possesses the ability to think individually and co-operatively	Demonstrates knowledge of engineering science and mathematics fundamentals

Table 2.3: The ASEE Attributes of a Global Engineer (Hundley & Brown, 2013)

2.4.6 IEA Graduate Attributes and Professional Competencies

Several accrediting associations for engineering qualifications developed outcomes-based criteria for evaluating engineering education programmes. A number of engineering bodies have developed competency-based standards for professional registration. International accords provide for the registration of graduates of accredited programmes of each signatory country by the remaining signatories. The Washington Accord provides for mutual recognition of programmes accredited for engineers. Similarly, the Sydney Accord caters for engineering technologists and the Dublin Accord caters for engineering technicians. These accords are based on the principle of substantial equivalence rather than exact correspondence of content and outcomes. The Graduate Attributes and Professional Competencies document records the signatories' consensus on the attributes of graduates for each accord as well as the signatories' consensus on competency profiles (IEA, 2013).

Graduate Attributes form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. Graduate attributes are defined for educational qualifications in the engineer, engineering technologist and engineering technician tracks. Graduate attributes are discipline dependent and reflect acceptable minimum standards. They are organised using twelve headings that identify the differentiating characteristic that allows the three professional titles to be distinguished (IEA, 2013).

The professional competency profiles for each professional category record the elements of competency necessary for competent performance that the professional is expected to be able to demonstrate at the stage of attaining registration. There is a professional competency profile for each of the three professional titles. Each profile consists of thirteen elements which are stated generically and are applicable to all engineering disciplines (IEA, 2013).

Tensions have always been part of designing engineering programmes, especially the tensions between theory and practice, between the relative importance given to science and to design (Coyle, 2009). Graduate attributes serve as a foundation for educational programme design, accreditation and international benchmarking as well as developing competencies for professional engineers, technologists and technicians (Wo, 2013).

The ASEE and IEA graduate attributes and the ENAEE learning outcomes are the basis of the international accords and international mutual recognition agreements and form the cornerstone of engineering programme design.

2.5 The Emergence of Engineering Professional Associations

This stream explores the evolution of, and contribution of, the engineering professions and professional associations including Engineers Ireland, the Engineering Council UK and ABET to the development of engineering education. The influence of other professional associations and international engineering collaborations is considered.

2.5.1 Engineering Professions

Traditionally the term '*profession*' was applied to the church, the army and the law. The twentieth century has seen a rise in the number of occupations into the ranks of the professions. Practitioners of these occupations tend to establish formal associations to control entry. This is achieved by a system of education and training, defined by the standards of acceptance and by adopting a code of practice (Heywood, 1983). Professional association membership provides the professional person with status. An organised profession admits recruits by means of an impartial test of knowledge and ability (Marshal, 1963). Certain jobs require by statute that the worker be certified as competent. The more specialised the requirements for knowledge and skills are, the greater the chance those who use that knowledge have to create a profession (Heywood, 1983).

Engineering professions are expected to exhibit the highest standards of honesty, integrity, impartiality, fairness and equity and must be dedicated to the protection of public safety, health and welfare. Their professional behaviour must adhere to the highest principles of ethical conduct (OECD, 2011).

Entry to the engineering profession in Ireland is regulated by Engineers Ireland. Engineers Ireland awards professional titles recognising educational attainment, career progression, ethical standards and achievement of its members. In the Republic of Ireland, Engineers Ireland are the sole authority to award the professional titles. Faculties/Schools of Engineering in Irish HEIs offer a wide variety of programmes broadly based on engineering and construction. Engineers Ireland accredits engineering programmes categorised according to eligibility for the professional titles of chartered engineer, associate engineer or engineering technician (Engineers Ireland, 2019).

Other professional associations accredit the construction and architectural programmes depending on the discipline field (quantity surveying, construction management, architecture, etc.). The Society of Chartered Surveyors Ireland (SCSI), The Chartered Institute of Building (CIOB) and The Royal Institution of Architects in Ireland (RIAI) are some of the more well-known and well-established professional associations in the construction and architectural fields. Each professional association has developed its own accreditation process and a 2019 publication by QQI has highlighted the similarities and differences between these accreditation processes (QQI, 2019). Some programmes are accredited to more than one professional association which means the same programme needs to be mapped to two or more sets of accreditation criteria.

Engineers Ireland states in their '*Engineering 2020. A barometer of the profession in Ireland'* report that the public holds engineers in extremely high regard where 77% think that engineering is a rewarding career for young people. The equivalent '*Engineering 2019'* report states that 43% of Irish adults would feel confident explaining what an engineer does. Engineers are in demand across all sectors of the Irish economy and a graduate can expect to earn over 33,000 Euros (Engineers Ireland, 2020), (Engineers Ireland, 2019). Despite this demand for graduates, the gender gap in engineering persists with 13% of the 2018 engineering graduates being female.

The supply of third level graduates and engineering apprentices is insufficient to meet the needs of Industry. The skills to perform many jobs are transforming. Engineers Ireland has identified that the in-demand skills over the next ten years will be communication, management, digitalisation and sustainability. Engineering organisations are taking initiatives to overcome skills shortages including investing in upskilling and reskilling current employees, offering flexible work options and collaborating with HEIs. In anticipation of Brexit, Engineers Ireland has reached agreements with their peer organisations in the UK on mutual recognition of qualifications (Engineers Ireland, 2020), (Engineers Ireland, 2019).

2.5.2 The Evolution of Engineers Ireland

On 6th August 1835, a meeting of civil engineers of the Board of Public Works signified their support for the formation of a society for their own improvement. Thus came into being '***The Civil Engineers Society of Ireland***' which had for its object '*the promotion of science in general, but more particularly as connected with the profession of civil engineering'* (Cox & O'Dwyer, 2014).

A general meeting was held in August 1844 when it was resolved that '*the Institution of Civil Engineers of Ireland be formed for the promotion of mechanical science and more particularly for the acquisition of that species of knowledge which constitutes the profession of a civil engineer'*. ***The Institution of Civil Engineers of Ireland*** (ICEI) was to retain this title for the next 125 years (Cox & O'Dwyer, 2014). Meetings were held frequently and papers presented and discussed. The transactions (technical papers) of the ICEI were first published at the end of the session 1844-45 (Cox & O'Dwyer, 2014).

The ICEI received a Royal Charter of Incorporation in 1877 giving it real status as a body entitled to represent and act for the engineering profession in Ireland. The Charter names the then president and '*others who have formed themselves into a society for promoting the acquisition of that species of knowledge which appertains to the professions of civil and mechanical engineers, and for the advancement of engineering and mechanical science'*. The profession of mechanical engineering is mentioned for the first time. Two distinct professions would be catered for by the one organisation. The Royal Charter ensured the independence of the profession and control by its own members but the ICEI considered the charter precluded it from negotiations on conditions of employment (Cox & O'Dwyer, 2014).

Cumann na hInnealtóirí (CnaI) was established in 1928 and in 1941 its constitution became effective. The Cumann was empowered to negotiate on behalf of its members the fixing of wages or conditions of employment. It succeeded in fulfilling its objective of advancing the standing, status and remuneration of its members and in protecting the profession as a rewarding career. The Cumann introduced the first issue of the Engineers Journal in December 1940 which later was issued quarterly and from 1949 it was, and still is, issued on a monthly basis as a published report or online. The unification of the Irish engineering profession was decided at the first joint meeting of the two councils which was held in 1968 and agreed that the ICEI (under another name) would continue in existence and the Cumann would cease to exist (Cox & O'Dwyer, 2014).

The ICEI reorganised the structure of the engineering profession so as to embrace all its branches. The organisation moved to Clyde Road where it resides today (Cox & O'Dwyer, 2014). The passing of the Institution of Civil Engineers of Ireland (Charter Amendment) Act 1969 provided for the formation of a new body to represent the engineering profession in Ireland. The Act embraced most areas of specialisation in engineering and combined the aims and objectives of both the Cumann and the ICEI. The Cumann survived in the title of the new professional body ***The Institution of Engineers of Ireland (IEI)*** and in the Irish language *Cumann na hInnealtóirí*.

The new professional body was recognised by an Act of the Oireachtas as the sole body licensed to award the title 'Chartered Engineer' within the state, and to maintain a register of Chartered Engineers practising in Ireland (Cox & O'Dwyer, 2014). In addition, the Act also set out that the new organisation should:

- promote the acquisition of knowledge which appertains to the profession of engineering and furthering the interests of the profession and its members;
- set up and maintain proper standards of professional and general education and training for admission to any category of membership of the Institution;
- maintain a proper standard of professional ethics and conduct (Cox, 2019).

Progress was maintained during the decade of the 1970s in regularising the committee structures, in developing the role of the divisions and regions, in organising seminars and the annual conference and in furthering the concept of the chartered engineer designation (CEng) and defining its importance for Irish engineering. A system of professional interviews for CEng designation was set up and expanded (Cox, 2019).

At the beginning of the 1980s, the actions taken to expand the membership of IEI included the initiative to draw up accreditation procedures. Accreditation of such programmes had traditionally been carried out by the various British engineering institutions, but it was decided that such procedures should be carried out by the IEI. Throughout the 1980s the IEI presented reports to government where engineering was involved including manpower planning. The IEI identified the need to support the supply of engineers and set up the Science, Technology and Engineering Programme for Schools (STEPS) to encourage secondary-school students to choose engineering as a career (Cox, 2019).

Throughout the 1990s, the IEI expanded considerably as membership increased to a total of 13,000 by 1996. In 1997, the IEI set up *The Irish Academy of Engineering* whose membership is made up of the most eminent engineers on the island of Ireland. The academy links the engineering professions in both jurisdictions in matters of common interest. It is a completely independent body with its own governing council and established by the IEI to be so. The Academy produces reports and commentaries on what it recognises as important. The Royal Academy of Engineering had been formed in Britain in the early 1980s. Similar academies had also been set up throughout Europe and further afield, all with the same concept of availing of the contributions of the most experienced engineers in the service of their respective countries. The Irish Academy maintains a close relationship with the Royal Academy of Engineering (Cox, 2019).

The IEI created, and continues to be engaged in, an active Continuing Professional Development (CPD) programme to continually update the professional skills of engineers throughout their careers. Since its foundation, the IEI through its divisional boards, regional committees and specialist groups, organises an extensive programme of lectures, seminars, and diverse other activities to meet identified needs. (Cox, 2019).

In the 2000s, the IEI created and implemented Corporate Development Plans, accredited software engineering programmes for the first time, prepared a Code of Ethics, expanded the STEPS programme, focused on increasing the number of engineers in Ireland, launched a new web-site, de-coupled ordinary membership from chartered membership, became a signatory to the Engineers Mobility Forum and created a new brand.

The IEI was rebranded as '***Engineers Ireland'*** in 2005, the operating version of the full legal title. A decision was made in 2006 to raise the standard for chartered engineer to a level nine master degree in engineering from January 2013. It was widely acknowledged that the standard of graduates coming out of Irish engineering schools compared favourably with those of many other developed countries (Cox, 2019).

From 2010 onwards Engineers Ireland significantly increased its membership to above 20,000 members, expanded CPD to become mandatory for all engineers, updated its by-laws, further expanded the STEPS programme, published the engineers journal online, developed close relationships with other professional associations, held annual excellence awards, became licenced to award the EUR-ACE accreditation label for masters degrees and developed the Engineers Ireland Strategy 2017-2020 (Cox, 2019).

The new vision statement in the Engineers Ireland Strategy 2017-2020 is a '*community of creative professionals delivering solutions for society*.' A central function of Engineers Ireland's role is enhancing trust, respect, influence and understanding of the engineering profession (Cox, 2019).

According to Bligh (2005) people's behaviour and the way they interpret the problems presented to them reflect the standards they believe underpin their professional practice. These standards are made explicit in codes of conduct/ethics. The *Engineers Ireland Code of Ethics* is a clearly defined set of standards of ethics and conduct that applies to all categories of membership of Engineers Ireland. Members must ensure that they behave with integrity, be aware of their responsibilities to themselves, to society, to clients, employers and colleagues and strive to maintain the highest levels of competence in their engineering discipline (Engineers Ireland, 2015).

Engineers Ireland has responsibility for all the engineering disciplines in Ireland and accreditation of engineering programmes is managed by their accreditation board. The Engineering Council UK has similar responsibilities for all the engineering disciplines in the UK but operate in tandem with discipline specific institutions, such as the Institution of Civil Engineers. Accreditation of engineering programmes is carried out by the discipline specific institutions with oversight from the Engineering Council UK.

2.5.3 The Evolution of the Engineering Council UK

The Society of Civil Engineering was formed in 1771. This became the *Institution of Civil Engineers* in 1818 and gained a Royal Charter in 1828. *The Institution of Mechanical Engineers* was formed in 1847 (Royal Charter in 1930). Each discipline of engineering formed its own body from the 1850s onwards. For example, the electrical engineers in 1871, the structural engineers in 1908 and the computer society in 1957 (Chapman & Levy, 2004). In 1923 the Engineering Joint Council was set up but faded away in 1937. In 1962 the Engineering Institutions Joint Council was established and this became in 1965 the Council of Engineering Institutions (CEI) and was awarded a Royal Charter (Coyle, 2009).

The distinguishing feature of the British Engineering Institutions was the fact that they were the main sponsors with the UK Department of Education of the national certificate system (Payne, 1969). This enabled persons to obtain professional membership via part-time study (Heywood, 1974). The 1961 White Paper indicated that national certificates would be for technicians (Ministry of Education, 1961). The Engineering Institutions proposed changes in their regulations which would exclude those with national certificates from membership. The professional institutions felt that the prestige of engineering could be raised if the part-time route to professional membership was abolished and entry to corporate membership was conditional on full-time or sandwich programme education to degree level (Heywood, 1974).

The status of professional associations was related to the level of education attained by intending members. Relating occupation, profession and education in this way led to a number of sub-professions seeking professional body status in the mid-1960s (Heywood, 2020). The chasing of some professional qualifications begins at age 16, the effect on individuals is that they get locked into a sub-system within a system. This can lock people into pre-ordained career routes (Marshal, 1963). The educational ladder leads into the sub-professions but there is no ladder leading out. The professional grade above is entered by a different road, starting at a different level of the education system (Heywood, 2020).

The creation of the NCTA and the CNAA, as described in Stream 2.3, led to substantial rethinking among the professional associations. The importance of validation as a means of confirming status did not escape the notice of the professional associations and they then sought to recognise HEI courses and programmes in the public sector and in the universities. The professional associations increasingly visited universities and college departments as part of their own accrediting process (Heywood, 1983).

The CNAA supported this link '*where qualifications were linked to statutory requirements it was agreed that representatives of appropriate professional associations should accompany visiting partie*s' (Davis, 1980). The CEI sent representatives on CNAA validation site visits to HEIs. There was an unconscious promotion of professional values (Heywood, 1983).

When most of the education for industry was part-time, programmes were validated by the professional associations through the examination system in the public sector. University programmes were accepted in their own right and their graduates obtained recognition without difficulty. The professional associations did not conduct extensive appraisals of the kind conducted by the CNAA (Heywood, 1983).

As an outcome of the Finniston '*Engineering our Future'* report, the ***Engineering Council*** was formed in 1981 by Royal Charter. At that time there were 53 Institutions under its remit. In 2001, the original Engineering Council was replaced by the ***Engineering Council UK*** and the Engineering and Technology Board. The Engineering Council UK retained its registration and qualifications role (Chapman & Levy, 2004).

The Engineering Council UK is the regulatory body for the engineering profession. The Engineering Council holds the national registers of over 222,000 engineering technicians, incorporated engineers, chartered engineers and technologists. To apply for registration of one of these titles, a candidate must first join one of the engineering associations currently licensed by the Engineering Council to assess candidates. In addition, the Engineering Council sets and maintains the internationally recognised standards of professional competence and ethics that govern the award and retention of these titles. The Engineering Council UK works closely with partner organisations such as Engineering UK and the Royal Academy of Engineering (The Engineering Council, 2020).

One of the world's most influential professional associations in the accreditation sphere is the Accreditation Board for Engineering and Technology in the USA. ABET's *ECriteria 2000* is utilised as the standard by many international mutual recognition agreements for assessing substantial equivalence of education programmes. ABET accredits engineering education programmes in thirty-two countries globally. The next section briefly describes the development of ABET as a professional association.

2.5.4 The Emergence of the Accreditation Board for Engineering and Technology, USA

The origins of the primary engineering professional association in the USA was quite different from those of the corresponding professional associations in Ireland and the UK. Whereas the latter professional associations were established to enhance the professional standing of engineering, in the USA the impetus came from a need to limit membership of the profession during the Depression of 1929 when there was an oversupply of engineers (Layton, 1971).

The Accreditation Board for Engineering and Technology (ABET) was founded in 1932 as the Engineers Council for Professional Development (ECPD). Seven engineering societies were created within ECPD which focused on guidance, training, education and professional recognition of engineers and included the Society for the Promotion of Engineering Education (Coyle, 2009).

In 1933, ECPD began evaluating the quality of engineering education programmes. By 1940, ECPD had accredited 461 engineering curricula at 129 HEIs in the United States. Another 104 curricula received provisional accreditation. ECPD was renamed *ABET* in 1980 and in 1985 the label further changed to 'ABET, Inc.' In 2005, to reflect its expanded scope, ABET used the acronym ABET only (Coyle, 2009).

ABET is a non-profit, 1SO 9001 certified organisation, that accredits HEI programmes in applied and natural science, computing, engineering and engineering technology. ABET's thirty-five member societies provide the experts who develop the criteria and set the standard of ABET's accreditation process. Thirty-five member societies, representing more than 1.5 million professionals, set policy, develop strategy and conduct accreditation activities in thirty-two countries on behalf of their professions (ABET, 2020).

By 2009, 2,700 programmes were accredited by ABET at 550 HEIs. Today, ABET accredits 4,144 programmes at 812 HEIs in 32 countries. Each year 2,200 experts from the thirty-five member societies contribute to ABET's goal of assuring confidence in STEM education (ABET, 2020). Like the Engineering Council UK, ABET works in tandem with its member societies, who accredit engineering programmes on its behalf.

2.5.5 Influences of Other International Professional Associations

Student mobility is seen as a powerful means to support the creation of an international market of professional and qualified workers. The best-known framework of international student mobility is the European Erasmus programme. The European Credit Transfer System (ECTS) is an institutional framework for credit recognition and transfer for students studying from abroad and is in existence since 1996. It is the basis of credit transfer for mobile students between cooperating HEIs (Van Damme, 2001).

The most powerful inducement to internationalising curricula has come from the impact of internationally organised professional associations. The engineering, medical and legal professions have been very active in this area (Van Damme, 2001). Professional associations, organised at an international level, thus have exerted a harmonising influence on standards and curricula in view of the professional accreditation of programmes and professional recognition of degrees in various countries (Mallea, 1998).

The International Engineering Alliance (IEA) aims to promote mobility of the profession via accords and agreements among members' economies. The vision of the IEA is '*to develop and maintain authoritative, independent international standards for engineering education and competence and promote wider recognition and adoption.*' The IEA has seven agreements of which three are related to engineering education and four are professional competence standards (Wo, 2013).

International engineering education agreements commenced in 1989 with the Washington Accord. This was in response to the worldwide need to improve mobility of engineers by mutual recognition of qualifications and competence (Wo, 2013). In November 1989, at a meeting in Washington, the USA, Ireland, Australia and New Zealand became the first to enter into a formal agreement to recognise each other's accreditation procedures. Each country had in place an established system of programme accreditation and mutual recognition had already been reached between Ireland and the United Kingdom (Cox, 2019). Subsequently, Britain and Canada also signed the agreement, which became known as the *Washington Accord* (Cox, 2019). The agreement was based on substantial equivalence of accreditation criteria and procedures. All countries associated with the Washington Accord have embraced outcomes-based accreditation criteria, which is a fundamental element of the graduate attributes (Wo, 2013).

The IEI became a signatory of the Sydney Accord in 2001 and the Dublin Accord in 2002, which are the mutual recognition agreements related to technologist and technician qualifications. The other signatories were the UK, South Africa and Canada, Australia, New Zealand, Hong Kong and China (Cox, 2019).

Activities involving professional competence within the IEA serve to establish a set of qualifications beyond educational experience. The competence recognition consists of:

- International Professional Engineers Agreement (IPEA) which serves the professional engineers worldwide;
- Asia Pacific Economic Co-operation Agreement (APEC). This is a regional agreement;
- The Agreement for International Engineering Technicians (AIET);
- The International Engineering Technologists Agreement (IETA) which serves the engineering technologists community worldwide (Wo, 2013), (ENAEE, 2020).

The important and significant work achievement of The European Federation of National Engineering Organisations (FEANI) was the establishment of a register of European engineering qualifications and the creation and fostering of the '*Eur Ing'* title. Eur Ing is a Pan-European designatory title denoting a recognised equivalence of academic education and training for European engineers, the objective of which was to facilitate the free movement of engineers throughout Europe. The Irish and British chartered engineer designations were recognised by FEANI as equivalent to Eur Ing. Engineers Ireland and FEANI signed an agreement to introduce the FEANI Professional Card from 2013 which was a forerunner of an EU-wide professional card (Cox, 2019). ENAEE aims at building a pan-European framework for the accreditation of engineering programmes and has created a common approach to accreditation which assists in simplifying different systems.

There are many other professional association influencers which are outside the scope of this literature review which aims to capture the most influential. Within the United States of America there is the American Society for Engineering Education (ASEE) and the Research in Engineering Education Network (REEN), worldwide the World Federation of Engineering Organisations (WFEO), the International Federation of Engineering Education Societies (IFEES) and in Europe the Engineering Education Research Network (EERN) to name but a few. There are national professional associations who have the same purpose, namely to support and improve engineering education in their respective domains.

2.6 Accreditation of Engineering Education Programmes

The establishment of accreditation procedures for all engineering programmes incorporating the learning outcomes approach is a relatively recent development and is accepted in many countries and jurisdictions. The main steps involved in the Engineers Ireland accreditation process are revealed. A selection of examples of international accreditation agencies and the date of commencement of their current accreditation processes are illustrated to indicate the range of accreditation activity worldwide.

2.6.1 Context of Irish and European Engineering Education Programme Accreditation

Historically, accreditation has been a feature of the concerns and activities of professional associations throughout their development but the modern accreditation process is a relatively recent development in Europe, dating from 1982 in Ireland. An accredited degree programme is one that has gone through a rigorous quality control assessment and has been approved by a national or international accrediting agency. Accreditation provides an educational institution or a programme of study with credibility (Wyne, 2010).

Accreditation of engineering programmes in Irish HEIs had traditionally been carried out by the relevant British engineering institutions. At the beginning of the 1980s, accreditation procedures were developed to be implemented by Engineers Ireland in assessing the various engineering programmes in the HEIs in Ireland.

Engineers Ireland established an Accreditation Committee in 1980, its brief being to prepare a report on a national system of accreditation of engineering education programmes. The report of this committee, which set out in great detail proposed accreditation procedures, was approved by Engineers Ireland’s Executive and Council in 1981. It was then circulated to all schools of engineering in HEIs. The process of accreditation was invaluable in affording Engineers Ireland an influential voice in subsequent international negotiations about the equivalence of qualifications in Europe and elsewhere in the world (Cox, 2019).

The initial accreditations by Engineers Ireland under the new procedures were carried out in Trinity College Dublin and UL in 1982 and in all other HEIs in 1983. The accreditation system is controlled by the Engineers Ireland accreditation board. In subsequent years accreditation of established and new programmes has continued, re-accreditation generally being at five yearly intervals. The accreditation procedures are updated regularly, approximately every ten years.

In Europe, under the auspices of FEANI, a group of individuals representing European engineering professional bodies was brought together to form the *European Standing Observatory for the Education of Professional Engineering (ESOEPE).* ESOEPE submitted a proposal to set up the EUR-ACE label with the objective of ensuring consistency between national engineering accreditation systems (Coyle, 2009).

The European Commission supported the EUR-ACE project in 2005. The EUR-ACE partners are six European engineering networks and eight national associations (ASIIN-Germany, CTI-France, EC-UK, Engineers Ireland, COPI-Italy, OE-Portugal, UAICR-Romania and RAEE-Russia). The EUR-ACE partners established ENAEE in 2006. ENAEE's purpose is to build confidence in systems of accreditation of engineering degree programmes within Europe. The ENAEE EUR-ACE accreditation process limitations include:

- Accreditation would be the result of a process of certifying the suitability of an engineering programme as an entry route to the profession;
- Accreditation would involve periodic assessment against accepted standards;
- Accreditation would involve peer review of written and oral information by trained and independent panels, including academics and professionals;
- Accreditation will be only of each engineering programme (Coyle, 2009).

The ENAEE EUR-ACE accreditation criteria for first cycle (bachelor) and second cycle (master) degree programmes have been established in line with the Bologna Declaration. The graduates of all accredited engineering degree programmes with the EUR-ACE label could be recognised by all other accreditation agencies authorised to issue the EUR-ACE label, in a similar modus operandi to the Washington Accord (Coyle, 2009). EUR-ACE engineering programme outcomes were also grouped into eight headings:

- Knowledge and understanding;
- Engineering analysis;
- Engineering design;
- Investigations;
- Engineering practice;
- Making judgements;
- Communications and teamworking
- Lifelong learning (ENAEE, 2020).

2.6.2 The Engineers Ireland Accreditation Process for Engineering Programmes

Engineering education programmes which satisfy the appropriate criteria laid down by Engineers Ireland are deemed to meet the education standard required of individuals seeking one of the registered professional titles of Chartered Engineer, Associate Engineer and Engineering Technician. Holding an accredited engineering qualification represents the first phase of the formation process for achieving registration as an engineering professional.

Engineers Ireland have regard to the criteria of its international partners and has based its approach on programme outcomes (Engineers Ireland, 2015). Outcomes-based accreditation of engineering education is emerging as a driving force for engineering programme quality assurance and is an efficient way to ensure that engineering graduates have the skills and knowledge to perform satisfactorily as competent engineers.

Engineers Ireland have approved accreditation criteria set out in their '*Accreditation Criteria for Professional Titles'* document. This document provides guidelines to HEIs on resources, entry standards, programme duration and structure, transfer and mobility, programme outcomes and area descriptors. Programme area descriptors and programme outcomes echo those set by the ENAEE and include science and mathematics, discipline specific technology, software and information systems, design and development, engineering practice and social and business context (Engineers Ireland, 2014).

Engineers Ireland have published a guidance document for HEIs describing the accreditation process titled '*Procedure for Accreditation of Engineering Education Programmes'* which sets out in detail what is required of the HEIs during the process. The component sections of the self-evaluation document are clearly identified with emphasis on the achievement of the programme outcomes (Engineers Ireland, 2015).

The main steps in the Engineers Ireland accreditation process are the preparation of the self-evaluation documentation to be provided by the HEI to Engineers Ireland, the application procedure, the desk review by Engineers Ireland, the selection of the accreditation panel, the setting of the agenda, the visit of the accreditation panel to the HEI, the preparation and organisation of evidence material for review by the visiting accreditation panel, the accreditation panel report, checking for accuracy of the accreditation panel report and post visit activities.

HEIs forward to Engineers Ireland, in respect of each programme for accreditation, the self-evaluation programme document and electronic media, well in advance of the site visit. The programme document and electronic media should be organised as set out in the Engineers Ireland guidance document. The maximum number of programmes a panel can consider is three, covering a maximum of two different educational levels (Engineers Ireland, 2015).

Once the self-evaluation document has been submitted, the accreditation panel is appointed by Engineers Ireland comprising a panel chair and two assessors, one of whom will be the rapporteur. The chair co-ordinates the site visit activities and attends the relevant meeting of the accreditation board. The chair also functions as an assessor and the rapporteur is responsible for producing an agreed accreditation report (Engineers Ireland, 2015).

The two-day agenda for the accreditation site visit to the HEI is agreed between Engineers Ireland and the HEI representatives and follows a similar format to that set out in the Engineers Ireland guidelines.

The site visit normally includes:

- A briefing session for panel members;
- An introduction to the programme(s) by HEI management;
- A tour of the facilities which support the programme(s);
- Examination of programme evidence in the evidence room(s). The evidence is provided per module for all forms of assessment (exam papers, exam scripts, coursework reports and laboratory practical work) and organised on the programme outcomes basis;
- Interviews with graduates, students and employers per programme;
- Staff meeting to discuss common concerns such as work placement or mathematics;
- Preparation of the draft panel report(s) which may contain commendations, conditions and/or recommendations;
- Final meeting with senior management to outline the findings in the draft report(s).

The panel report is agreed by the panel and prepared in a pro-forma document. Once the accreditation report is complete and agreed by all the panel members, it is sent to Engineers Ireland who then forwards the report to the HEI to check for factual accuracy. The panel report is considered by the Engineers Ireland accreditation board and the Executive Committee of the Council.

The accreditation decision is communicated to the HEI who submits to Engineers Ireland, within six months, its plans to address any conditions attached to the decision. The panel reports are not published but the list of accredited programmes is published on the Engineers Ireland website (Engineers Ireland, 2015). The accreditation board ensures consistency of approach across all the programmes accredited by Engineers Ireland (QQI, 2019).

There are many similarities between the programmatic review and accreditation processes in terms of procedure but they differ in their implementation. The programme teams prepare self-evaluation documentation for both processes but the document content is different. Both processes require the selection of panel members, setting of an agenda, site visit to the HEI, preparation of a panel report and organisation of evidence for review by the panel but the implementation detail of each of these steps varies depending on whether it is the validation or accreditation process.

Some steps are the same including the checking for accuracy of the panel's report and some post visit activities. Unique features of the programmatic review include the internal preparative review and approval by academic council. Unique features of the accreditation process include the Engineers Ireland desk review, application procedure and approval by the Engineers Ireland accreditation board.

Overall, the processes have similar methodologies but have differences in the implementation details which have evolved over time.

2.6.3 Examples of International Accreditation Processes

The Irish and British engineering associations have agreed mutual recognition of accreditation procedures. The first agreement was signed with the Institution of Electrical Engineers in 1982 and formed the basis of all subsequent agreements (Cox, 2019). Table 2.4 provides a small selection of the accreditation agencies who accredit engineering education programmes in their own jurisdictions. Accreditation is a relatively recent phenomenon in its current form of outcomes-based accreditation as shown in Table 2.4.

Country	Engineering Accrediting Agency	Year Accreditation Commenced	Reference
Ireland	Engineers Ireland (IEI)	2009	(Engineers Ireland, 2014)
United Kingdom	Engineering Council (UK)	2008	(ECUK, 2008)
France	Commission des Titres d'Ingénieur (CTI)	2007	(CTI, 2020)
Germany	German Accreditation Council	2002	(www.eurashe.eu)
Russia	Russian Association of Engineering Education (RAEE)	2004	(Pokholkov, et al., 2004)
Portugal	Portuguese Order of Engineers	2008	(www.rehva.eu)
USA	American Board for Engineering and Technology (ABET)	2000	(ABET, 2008)
Malaysia	The Engineering Technology Accreditation Council (EAC)	2000	(www.eac.org.my)
China	The National Expert Committee for Engineering Education Accreditation	2008	(National Expert Committee for Engineering Education Accreditation, 2008)

Table 2.4: A Small Selection of National Accrediting Agencies

2.7 Aligning Programmatic Review and Accreditation Processes: Time for a Change?

The analysis presented so far in the chapter has identified the various histories, processes and interactions between validation and accreditation, nationally and internationally. However, concurrent with this research study, there have been five recent publications and reports that have directly or indirectly appraised the need for some kind of alignment or convergence in this area and will be appraised in this stream.

2.7.1 Professional Body Accreditation in Higher Education in Ireland

QQI commissioned a project with PARN '*to identify how and if professional body activity impacts upon the HEI quality assurance context with the aim of discovering opportunities and benefits and alleviating challenges.*' PARN reported in July 2017 on their examination of professional body accreditation in HEIs in Ireland, from the perspective of the HEIs. Internal quality assurance is defined in the report as '*an ongoing, continuous process of evaluating (assessing, monitoring, guaranteeing, maintaining and improving) the quality of an education system, HEI or programme*.'

The PARN report includes an evaluation of the accreditation landscape through a definitive listing of types of accrediting associations and reviewing whether their activity is increasing or in decline with an analysis of compulsory and optional status. Human and resource costs are explored. Five further key issues are examined: institutional policies, nature of the relationship between external professional accreditation and internal quality assurance, benefits and challenges of accreditation and suggested ways to reduce costs (PARN, 2017).

PARN identified in excess of 180 professional associations who accredit education programmes in Ireland but some of them can also be regulatory bodies that regulate a profession. Some professional associations are defined by statute and membership can be compulsory in order to practice and many professional associations are bound by international agreements (PARN, 2017). This finding is consistent with the professional associations that accredit engineering and construction education programmes in the institute of technology sector in Ireland. This definitive listing of professional associations confirmed that Engineers Ireland interacts with most HEIs, more so than almost all other professional associations.

PARN discovered that the internal quality assurance processes and external accreditation by professional and regulatory associations operate independently of each other in many HEIs. Some of the other relevant highlights from the PARN study are as follows:

- Internal quality assurance is the responsibility of the HEI;
- All HEIs should have policies on accreditation, develop training documentation for staff and generate incentive structures for academics dealing with accreditation;
- Communication between the HEI and the professional association is key;
- QQI is responsible for the recognition of professional and other awarding bodies and will allow awards made by professional associations on the NFQ;
- QQI has longer term objectives of exploring opportunities for integration and streamlining of systems, exploring mechanisms that can reduce resource demand (staff and time) and identifying data sharing opportunities;
- QQI recognises that the periodic academic revalidations of programmes are a significant resource demand in addition to the professional accreditation processes;
- Professional association accreditation requirements appear to change with regularity which adds to the drain on resources (PARN, 2017).

In relation to the accreditation process, the PARN report recognises that the most popular methods of accreditation/regulation included a desk review, site visit, criteria review and review by peers but the site visit was the most popular. The highest frequency of engagement noted was for every five years. On average, 45 days of academic time and 30 days of administrative staff's time were required to initially secure professional accreditation. A significant amount of time is spent on producing documentation, preparing for the site visit and undertaking self-evaluation (PARN, 2017). The benefits and challenges of accreditation were outlined and suggestions for streamlining the processes and reducing duplication were explored and these will be discussed further in chapter eight of this thesis. All of the PARN report findings are relevant to the aims of this study although the PARN findings are generic and applicable to all professional associations and their accreditation processes. The PARN report does not compare or contrast specific accreditation processes or programmatic review processes but presents an overview of the accreditation sphere of influence.

Most HEIs have an institute wide policy for accreditation which supports the idea that there should be alignment between professional association accreditation and the internal quality assurance process (programmatic review). The PARN report recommends that '*the ways in which the aims of accrediting bodies differ and how these differences lead to variances in focus for accreditation processes'* should be investigated. In addition, '*Interactions between particular professional associations and HEIs'* is recommended for further research which mirrors the research question for this study and reinforces its significance.

The PARN report takes a landscape wide view of the professional association and regulatory body accreditation processes and does not focus in on individual cases. Many of the concerns and challenges raised in the report align with the motivation and aims of this research study. It is noteworthy that the PARN report recommends further research on the differences in quality assurance objectives of the professional associations and interactions between particular professional bodies and HEIs. This research study contributes to this ambition by triangulating the two QQI engineering standards and the Engineers Ireland accreditation criteria and it also contributes by investigating if the programmatic review and accreditation processes can be more closely aligned.

2.7.2 Accreditation/Approval of Higher Education Programmes by Professional Bodies

QQI published, in 2019, a corresponding report titled '*Accreditation/Approval of Higher Education Programmes by Professional Bodies. QQI Insights'* from the perspective of the professional associations and regulatory bodies that accredit/approve higher education programmes (QQI, 2019). In this report QQI selected eleven of the major professional associations (including Engineers Ireland, the RIAI and SCSI) and compared their accreditation processes under the headings of standards, evaluation, review of accreditation, monitoring arrangements and international links and collaborations.

While each professional association has a unique accreditation process, each follows the same general pattern for accreditation, diagrammatically represented in the report. The six accreditation process steps were the preparation of a self-evaluation report, a professional association desk review of the submitted documentation, a site visit to the HEI by the accreditation panel, preparation of an accreditation panel report, factual accuracy checking of the report and the final accreditation decision by the professional association (QQI, 2019). The Engineers Ireland process was discussed in more detail in section 2.6.2. of the QQI document but follows this pattern for accreditation.

QQI noted that there were some factors affecting the current accreditation/approval processes as follows:

- Many of the professional associations are establishing or updating standards and criteria through their accreditation boards on a regular basis;
- All of the professional associations have established comparable processes to accomplish the task of accreditation but operate independently of each other;
- The involvement of site visit panel members from other countries assists with the removal of bias and brings best practice from other countries;
- Almost all professional associations allow for conditions and recommendations to be included in the accreditation panel report;
- Accreditation approval is agreed for a finite period of time, normally five years;
- It would be prudent for each professional association to have a clearly defined appeals process;
- It is also essential to have the power to deny accreditation when appropriate;
- There seems to be ambiguity around what price is appropriate to charge for the accreditation process (QQI, 2019).

This QQI report details the accreditation processes of eleven of the most influential professional associations and recognises that the accreditation processes follow a similar design. The identified trends are indeed comparable with the Engineers Ireland accreditation process as set out in Section 2.6.2 and in practice.

Professional associations regularly review and update their accreditation criteria, operate independently from other professional associations, use conditions and recommendations in accreditation reports and have a periodic cyclical review of five years (normally). These trends and ambiguity around the costs of accreditation are also mentioned in the PARN report. Further comparisons are highlighted in chapter eight of this thesis.

This QQI report did not make any connection between accreditation and the programmatic review process in Irish HEIs which is the subject of this research but many of its findings are relevant to this research study. Similar to the PARN report, it is limited to a landscape wide view of the accreditation process from the perspective of all the professional associations.

2.7.3 Engineers Ireland Accreditation Review 2019

Engineers Ireland conducted a survey of accreditation volunteers/academics (n = 90) and engineering employers (n = 147), and reported on the survey outcomes together with the outcomes of the 'Engineering Education: Future Skills, Standards and Mobility' conference of 30th October 2019. The Engineers Ireland Accreditation Review 2019 report, circulated to the accreditation board members, observes that there is a '*strong desire to link/align the accreditation process in some way with the programmatic review process to reduce the administrative burden on HEIs*.' The report states that linking may not be possible for universities as reviews there are continuous and not subject to a major five yearly review.

The accreditation visit is considered valuable but very intensive for HEIs and panels. It acknowledges that '*accreditation and programmatic review serve different purposes and have a different set of programme outcomes and Engineers Ireland need to ensure compliance with international accords.*' It highlights that HEIs cannot afford the costs of overlapping, complex and potentially conflicting quality assurance processes. The report recommends that '*the processes should be synchronised as they are based on the same evidence'* (Engineers Ireland, 2019). Many of the report's recommendations are compared and contrasted with the recommendations of the PARN and QQI reports in chapter eight.

The sentiments in the Engineering Ireland Accreditation Review 2019 report align with the aims of this research study. The strong desire to link/align the accreditation process in some way to the programmatic process, identified in this report, is the core focus of this research study.

2.7.4 Joint Statement of Principles for Professional Accreditation

Universities Australia and Professions Australia issued a Joint Statement of Principles for Professional Accreditation in March 2016 with the objective that '*it is recognised that a complementary approach is necessary to harmonise the separate academic and professional accreditation processes and avoid duplication of effort*' (Universities Australia and Professions Australia, 2016). This statement supports the research question of the present study, particularly around the concept of bringing the separate quality assurance processes into closer alignment. The succinct Joint Statement sets out the scope, objectives, purpose, context, responsibilities and basic principles of accreditation.

The Joint Statement encourages that professional accreditation processes should base the evaluation of university programmes on published professional accreditation standards. Professions Australia and Universities Australia '*share a responsibility to develop complementary approaches to programme accreditation as well as alignment of professional standards and the learning outcome requirements of the Higher Education Standards Framework of Australia'* (Universities Australia and Professions Australia, 2016). This statement seems to spell out that accreditation and HEI quality assurance processes should be aligned. QQI are creating an Irish set of accreditation principles with reference to this document.

The trends emanating from the PARN and QQI reports are compared and contrasted with this Joint Statement in chapter eight of this thesis. The Joint Statement is a very high-level document which gives direction to the aspiration of Universities Australia and Professions Australia but does not give any specific details on how the ambition can be realised. The overarching principle of the Joint Statement reflects the research question of this research study.

2.7.5 Quality in Higher Education 2020

QQI published 'Quality in Higher Education 2020' as a synthesis report providing an overview of the main themes arising across the Annual Institutional Quality Reports submitted by the twenty HEIs and the National University of Ireland for the period from September 2018 to September 2019. Quality in Higher Education 2020 disseminates examples of good practice and provides a snapshot of the comprehensive quality assurance infrastructures in place in Irish HEIs, as well as the breadth of activities aimed at ensuring and enhancing the quality of teaching, learning, research and the learner experience.

For Designated Awarding Bodies, the annual institutional quality report provides a means for HEIs to detail their internal programme approval, monitoring and review policies and processes. This QQI report identifies the incorporation of professional association representatives onto some programme validation panels and states that '*the increased familiarity among professional associations with HEI internal processes may lead to opportunities to dovetail processes and reduce the burden of accreditation on HEIs and professional associations, which is to be welcomed*.' This research study endeavours to achieve this expressed intention in the QQI report by bringing the accreditation and validation processes into closer alignment.

2.7.6 The Remit of this Research Study

All five publications and reports have alluded to the need to converge, and perhaps merge, the programmatic review and accreditation processes in some way. The intrinsic conclusion from the five publications is the essence of the research question for this study. The reports give a broad view of the HEI quality and accreditation landscape applicable to all professional associations but do not indicate how any amalgamation of the processes could be realised for individual accreditation processes or for the institute of technology sector.

It is expected that this research study will contribute to this body of knowledge by analysing how the accreditation and programmatic review processes may be brought into closer alignment in sufficient detail to consider the inhibitors and supports for this challenge. It is envisaged that suggestions for the combination/alignment of the processes will evolve from the research together with their implications for engineering education and the primary stakeholders.

2.8 Conclusion

This literature review provides an appreciation of how engineering higher education evolved in Ireland and the United Kingdom and pays particular attention to the emergence of the programmatic review and engineering accreditation quality assurance processes. The discussion centres around education acts, special committee reports and national councils responsible for the quality assurance of engineering education.

The global and policy community influences on these policy driven processes are described and the gatekeeper roles of the primary stakeholders are emphasised. The most influential examples of how graduate attributes shape engineering education programme design are described. The main steps involved in the programmatic review process are outlined.

The development and advancement of engineering professional associations are discussed for Engineers Ireland, the Engineering Council UK and ABET. The influence of other professional associations and international engineering collaborations are mentioned. The creation of accreditation procedures for all engineering programmes incorporating the learning outcomes approach is a relatively recent development. The main steps involved in the Engineers Ireland accreditation process are explained.

Table 2.5 is a comparison summary of the development of the internal programmatic review and external accreditation processes in Ireland and the UK showing the timelines, organisations involved and main pivotal occurrences/legislation leading to their development.

Accreditation *Pivotal Occurrence/Legislation*	**Timeline**	**Programmatic Review** *Pivotal Occurrence/Legislation*
		Apprenticeship was the main engineering education system up to the 1940s in the UK and the 1960s in Ireland
	1796	Lectures on the principles of engineering in the University of Cambridge
	1812	Royal Engineering School established at Chatham
Establishment of the Institution of Civil Engineers in London. Sets own examinations for membership	1818	

Establishment of the Civil Engineers Society of Ireland. Renamed the Institution of Civil Engineers of Ireland (ICEI) in 1844 and had a royal charter in 1877	1835	
	1841	First professor of civil engineering appointed in the University of London
	1842	Professor of the practice of engineering appointed in Trinity College Dublin
Establishment of UK Engineering Institutions, other than civil	1850's onward	
	1921	UK Ministry of Education introduced a system of national certificates and diplomas
	1928	Cumann na hInnealtóirí (CnaI) established. Engineers journal commenced 1940
First accreditation of engineering programmes in Europe - CTI in France	1934	
	1938	The Spens Committee report on modernising the secondary school curriculum
	1943	The Norwood Committee report recommended the establishment of technical schools
	1944	The Butler Education Act recommended the formation of a (Percy) Committee on Higher Technological Education
	1945	The Percy Committee report identified five categories of technologists, recommended the establishment of technical colleges and the NCTA
	1955-1964	The NCTA oversaw standards and awards in technical colleges and created a validation process for engineering programmes
	1956	UK White Paper on Education created a four-tier system of technical education, founded CATs and encouraged sandwich programmes

	1963	The Robbins Committee Report recommended the establishment of the CNAA and that CATs become universities
	1964 - 1992	The CNAA oversaw standards and awards outside of the university sector. CNAA Subject Boards oversaw the development of the programme validation process
	1965	OCED Report on Education led to the introduction of free second level education in Ireland in 1966
	1967	UK White Paper established Polytechnics
ICEI Charter Amendment Act renamed ICEI to the Institution of Engineers of Ireland (IEI) and CnaI ceased. Established the standard to become a chartered engineer and to maintain a register of same	1969	
	1972	Regional Technical Colleges established, later renamed to Institutes of Technology
	1972 - 2001	NCEA established. Its main function was to validate and review (programmatic review) higher education programmes of study and was put on a statutory footing in 1979. Programme aims and objectives are included in validation proposals
CNAA allowed professional association representatives to attend validation site visits in HEIs	1980 onwards	
	1980	Finniston Committee Report (Engineering Our Future) introduced B.Eng. awards for engineering programmes
The IEI developed accreditation criteria and standards to assess engineering programmes in HEIs	1981	
UK Engineering Institutions accredited engineering programmes in Ireland	Up to 1982	

The IEI started accrediting engineering programmes in Irish HEIs	1982	
	1983	CNAA introduces joint accreditation where polytechnics conducted the internal validation and the CNAA the external validation of programmes of study
FEANI established the 'Eur Ing' title	1987	
	1988	Education Reform Act allowed the CNAA to introduce *Accreditation of Institutions* where HEIs had full responsibility for validation and review of programmes
The Washington Accord is agreed as an international mutual recognition agreement.	1989	
	1992	UK Further & Higher Education Act dissolved the CNAA and the Open University awards degrees in non- accredited HEIs. HEQC established
	1995	Irish White Paper on Education outlines quality assurance procedures for higher education
	1995-2005	Learning Outcomes, Programme Outcomes and the Bologna Declaration drive engineering programme design
Engineers Ireland accreditation criteria updated and expressed in programme outcomes and area descriptors	1997, 2014 and 2020	
	1997	UK QQA established and HEQC dissolved
	1999	Qualifications (Education and Training) Act dissolved NCEA and created HETAC. HETAC had the validation role of NCEA and the power to give HEI's delegated authority
	1999	Bologna Declaration establishes first and second cycle higher education awards

ECriteria 2000 published by ABET, USA. Global model for accreditation	2000	
The Sydney Accord agreed	2001	
ESOEPE established and became ENAEE in 2006. Established the EUR-ACE label in 2005 and the EUR-ACE Framework and Guidelines in 2015	2001, 2005, 2006 & 2015	
The Dublin Accord agreed	2002	
	2003	NQAI established the NFQ
The IEI was rebranded to Engineers Ireland	2005	
	2006	European Qualifications framework established
	2012	Qualifications and Quality Assurance (Education and Training) Act dissolves HETAC and creates QQI
Engineers Ireland raise the C. Eng education level to level nine	2013	
EU Directive 13/55/EU makes Engineers Ireland the sole competent authority in Ireland to award the chartered engineering title	2013	
	2015	European Standards and Guidelines (ESG) published
Engineers Ireland accreditation procedures guidance updated	2015	
	2020	Institutes of Technology became Designated Awarding Bodies and can validate and make their own awards

Table 2.5: Summary Comparison of the Development of the Validation and Accreditation Processes

Five recent publications and reports have supported the need for this research but illustrate that there is a gap in knowledge with regard to how the programmatic review and accreditation processes can be brought into closer alignment. This research endeavours to address this deficiency.

Chapter 3: Research Methodology

3.1 Overview

Research is a systematic investigation where data is collected, analysed and interpreted in some way to understand, describe, predict or control an educational phenomenon (Mertens, 2005). According to MacKenzie & Knipe (2006), it is the choice of the philosophy (theoretical framework or paradigm) that sets down the intent, motivation and expectations for the research. Philosophy is important in educational research as it shapes how to formulate the research questions, how to seek information to answer the questions and the underlying assumptions guiding the research (Cresswell, 2007).

The philosophical basis of this research will be explored in this chapter and the rationale behind the choice of research paradigm, ontology, epistemology, axiology, methodology and research methods will be provided. The content of this research methodology is organised into seven streams and follows the philosophical aspects of the research design from paradigm selection through to research methods and concludes with the researcher's interpretation of the common characteristics across the research design.

A brief introduction to the major types and constituents of research philosophies in educational research are explained in stream two together with the researcher's positionality in this research. The pragmatist paradigm and the rationale for its use in this study is considered in stream three. Streams four and five discuss the ontological, epistemological and axiological aspects of the research and the reasons for the use of interpretivism. Grounded theory is explored in stream six. Stream seven outlines the research methods that are used for data collection including the Delphi Technique. Stream eight outlines the theoretical framework for the research and the consistent philosophical thread running through the research design is portrayed in tabular format.

3.2 Research Philosophy in Engineering Educational Research

3.2.1 Constituents of Research Philosophy in Engineering Educational Research

This stream briefly describes the predominant elements of research philosophies used in engineering educational research. The following streams examine each philosophical element in turn and indicate how they will be applied in the research design. Chapter four provides details of the application of these elements in the research.

Paradigms are sets of beliefs and practices, shared by communities of researchers, which regulate inquiry within disciplines (Bunniss & Kelly, 2010). Weaver & Olsen (2006) suggest that the various paradigms are characterised by ontological, epistemological and methodological differences in their approaches to conceptualising and conducting research, and in their contribution towards knowledge construction.

Ontology refers to the nature of reality and whether an objective reality exists independent of the researcher (Cresswell, 1994). Quantitative research derives from an ontological position where a single reality exists that is static and fixed and the world is ordered according to an objective truth. Qualitative research embraces the idea of multiple realities which are subjective and changing and there is no one truth (Bunniss & Kelly, 2010).

Childers & Hentzi (1995) purport that epistemology refers to the nature and source of legitimate knowledge and the ability of research participants to possess knowledge. Knowledge is considered value free and objective within a positivist paradigm. Theory may be developed to accurately describe the world in quantitative research (Bunniss & Kelly, 2010). In qualitative research, the researchers get close to the participants being studied. Knowledge is subjective and there is no one or correct way of knowing (Cresswell, 2007).

Axiology is the role of values in the research process. Researchers' biases in quantitative research need to be controlled and not expressed in the study. Qualitative researchers make their values known in the study (Cresswell, 2007).

Research methodology refers to the overall approach to the research, such as why particular methods are chosen, and is linked to the research paradigm (Giacobbi, et al., 2005). Quantitative researchers aim to discover what exists using scientific method. Theory is established deductively (Bunniss & Kelly, 2010). Qualitative research is characterised by inductive, emerging theory and shaped by the researcher's experience in analysing data.

MacKenzie and Knipe (2006) define research methods as systematic techniques, procedures or tools used for the collection and analysis of data. Quantitative researchers tend to use questionnaires and statistical testing of hypotheses whereas qualitative researchers use observation, interviews or use of narrative (Bunniss & Kelly, 2010).

Mack (2010) states that ontological assumptions inform epistemological assumptions which in turn inform the research methodology and all affect the methods used to collect data.

Lather (2006) claims that educational research conducted within a positivist paradigm primarily asks what is true and what can be known. Positivist (quantitative) research assumes that knowledge can be obtained through the rigorous application of empirical data-collecting methods but makes little concession to social and historical context around the phenomenon being researched. Interpretivist (qualitative) research creates knowledge through the social process of construction of meaning in relation to the context in which the research is conducted (Nunes & McPhearson, 2003).

3.2.2 The Researcher's Positionality in the Research

I am a Dean of a Faculty of Engineering in an institute of technology in Ireland. My role involves five yearly cyclical programmatic review of all the faculty's programmes as well as accommodating accreditation visits from a number of professional associations (at least two per year). My faculty comprises five departments with over 80 programmes offered across engineering, information technology and science. Preparation for programmatic review takes at least eighteen months, and with five departments may take two years or more to complete. The programmatic review and accreditation processes occupy a considerable proportion of my worktime.

I participate in, and sometimes chair, faculty/school of engineering programmatic reviews in institutes of technology and universities across Ireland. This has given me an insight into how these quality assurance processes are conducted in other HEIs and how staff view the relevance and importance of the quality assurance processes to their teaching.

I also participate in the Engineers Ireland accreditation panel visits to many of the institutes of technology and universities in Ireland. I am a member of the Engineers Ireland accreditation board which gives me a detailed insight into how the accreditation process is being conducted in all the HEIs in Ireland.

I am a member of the Technological Higher Education Association (THEA) Council of Heads of School of Engineering (CoHSE), Council of Heads of School of Science (CoHSS) and Technological Higher Education Apprenticeship Committee (THEAC). Membership of these fora allows me to connect with colleagues in other HEIs and to share concerns and experiences of the quality assurance processes.

Therefore, I am immersed in these processes from the standpoint of a senior manager in a HEI, from the external academic assessor and chairperson on an external programmatic review panel viewpoint and as an external academic assessor on an Engineers Ireland accreditation panel. This position allows me to consider the impact of the current programmatic review and accreditation processes and whether they could be brought into closer alignment.

3.3 Paradigm Selection

3.3.1 Research Philosophy and Research Question

According to Seidman (1998), the primary way a researcher can investigate an educational process is through the experience of the individual people involved in that process. In the social sciences the majority of research methods yield data that are, to some degree, unreliable as they must be obtained indirectly. Educational research has a responsibility to educational practice as practitioners of education demonstrate knowledge in everyday activity (Kelly, 2009).

The objective of this research is to explore if the programmatic review and accreditation processes can be brought into closer alignment, which would then allow for the establishment of a single collaborative process for engineering education or facilitate sequential occurrence of the processes within the same timeframe. The research question for this research is

'How can the external accreditation process of engineering education programmes in Ireland be brought into closer alignment with the internal quality assurance programmatic review process of these programmes?'

Creswell (2007) suggests that the choice of whether we use qualitative, quantitative or mixed methods must be driven by the research question. Mixed Methods is a combination of quantitative and qualitative methods for pragmatic reasons. Mackenzie and Knipe (2006) claims that it is the paradigm and research question which should determine which data collection and analysis methods will be the most appropriate for a research study. Quality in research is defined by the integrity and transparency of the research philosophy and methods, rather than the superiority of any one paradigm (Bunniss & Kelly, 2010). Pragmatists subscribe to the philosophy that the research question should drive the research methods used (Onwuegbuzie & Leech, 2005).

The research question driving this study led to the pragmatism paradigm in the research design and data collection with interviews and questionnaires to establish the perspectives of stakeholders. Lincoln, et al. (2011) state that this research process could involve both qualitative and quantitative approaches to data collection and analysis.

3.3.2 Pragmatism

Pragmatism is a philosophy of knowledge construction that emphasises practical solutions to applied research questions. The term *pragmatism* comes from a Greek word meaning *action* from which the English word *practice* was derived (Giacobbi, et al., 2005). Truth is known only to the extent that it is useful in practice. An imperative of pragmatism is that knowledge should make a difference in action (Goldkuhl, 2012) and research always occurs in social, historical and other contexts. Bradley (2003) considers that pragmatism allows both positivist and interpretivist paradigms for carrying out educational research. Mixed methods research involves a combination of procedures where two or more data collection techniques and forms of analysis are used and all contribute to the final results (Tgshakkari & Teddlie, 1998).

Onwuegbuzie and Leech (2005) purport that by utilising both quantitative and qualitative techniques within the same framework, pragmatist researchers can incorporate the strengths of both methodologies and may select research methods with respect to their value for addressing the underlying research question.

Pragmatism embraces mixed method approaches to applied research questions (Giacobbi, et al., 2005) and mixed methods approaches to data collection are often used. Green et al. (1989) argue that there are five broad reasons for using mixed methods research as follows:

- Triangulation – seeking convergence and corroboration of results from different methods studying the same phenomenon;
- Complementarity – seeking elaboration and clarification of the results of one method with the results of the other method;
- Development – using the results from one method to help inform the other method;
- Initiation – discovering contradictions that lead to a review of the research question;
- Expansion – expand the breadth of inquiry by using different methods for different inquiry components.

Pragmatism is derived from the teaching of Charles Sanders Peirce (1839-1914), who believed that thought must produce action. Pragmatism has its origins in the work of Peirce, James, and Dewey with contemporary support from Rorty (Giacobbi, et al., 2005). James (1907) defined pragmatism as an attempt to find practical solutions to contemporary problems. Dewey (1931) professed that all learning is dependent on the context of place, time and circumstance. Rorty (1991) described pragmatism as a rationale for a non-ideological, compromising, reformist muddling through.

According to Goldkuhl (2012), pragmatism is concerned with action and change and the interplay between knowledge and action which makes it suitable for inquiries into organisational change where the aim is for intervention and change. Pragmatism is a suitable paradigm for case study researchers who use both qualitative and quantitative data (Cresswell, 2007).

The research question guiding the present study is based on a practical engineering education problem and some of the outcomes of the research may be transferable to other accreditation processes. Triangulation, complementarity and development are three of the five broad reasons identified by Green et al. (2005) for using mixed methods research that are applicable to this research focus.

Other features of the pragmatist philosophy which resonate with the nature of the research question for this study are as follows:

- Knowledge should make a difference in action;
- The truth is known only to the extent that it is useful in practice;
- Pragmatism is concerned with action and change;
- Case study researchers may use qualitative and quantitative data as qualitative evidence on its own is often considered ‘soft’;
- Pragmatist reality is what is useful and practical;
- Reality is known by objective and subjective evidence;
- Knowledge reflects both the participant’s and researcher’s perspectives.

From the above literature and the applied, practical nature of the research question, the pragmatism paradigm will be the most appropriate philosophy for this research.

3.4 Ontological Considerations

Ontology is a discipline that concerns itself with what exists. The questions relevant to ontology include questions about reality that are beyond and behind those capable of being tackled by the methods of science. Knowledge should be evaluated on the grounds of how accurately it reflects reality. From a pragmatic point of view, social scientists study activities of people within a specific community (Kivinen & Piiroinen, 2008).

Pragmatism ontology is symbolic realism where reality is what is useful, practical and what works. Pragmatism research is oriented to be used in action for making a purposeful difference in practice. To perform changes in desired ways, action must be guided by purpose and knowledge (Goldkuhl, 2012). Rorty (1990) believes that pragmatists are pluralists who believe in multiple realities based on individual experience. Bradley (2003) observes that pragmatists see research outcomes as connections between actions and consequences.

For pragmatists, only those things that are experienced or observed are real and reality is constantly changing. There is no absolute and unchanging truth (Cohen, 1999). Mack (2010) postulates that reality is indirectly constructed based on individual interpretation and is subjective and there are multiple perspectives of one incident. Reality can be explored and constructed through human interactions and actions.

3.5 Epistemology and Axiology in this Research

3.5.1 Epistemological Considerations

Reality is known by using objective (deductive) evidence and subjective (inductive) evidence (Lincoln, et al., 2011). The constructed knowledge will reflect both the researcher's and participant's views of the research area.

Pragmatism is not restricted to explanations (key of positivism) or meanings (key of interpretivism) but also includes prescriptive (giving guidelines), normative (exhibiting values) and prospective (suggesting possibilities) qualities. All these knowledge forms are part of pragmatist epistemology called constructive knowledge (Goldkuhl, 2012). It is possible to combine a pragmatist paradigm with interpretative thinking and methods (Goldkuhl, 2012). The epistemological aim is for constructive knowledge that is appreciated for being useful in action (Goldkuhl, 2012).

Paradigms that assume a subjective ontology create a knowledge based on participants' experiences. The research question was answered in a manner that is consistent with the interpretative epistemology as follows:

- Knowledge from the perspectives of people where reality is indirectly constructed;
- Knowledge created between the researcher and the participants giving multiple perspectives.

Thus, an interpretative epistemology guided the research design in conjunction with the pragmatism paradigm. Data collection with two rounds of interviews and one round of a questionnaire were utilised to establish the perspectives of stakeholders, with feedback given to participants at the end of the first two rounds of data collection.

3.5.2 Interpretivism

Interpretivists believe that reality is socially constructed (Husserl, 1965), where research is through the direct experience of people (Mack, 2010). Inherent in social constructivism is an interpretative epistemological position. The interpretative educational research paradigm is interested in how individuals develop subjective meanings, formed through interaction with others, that reflect their perspective of their experiences. Cresswell (2007) confirms that knowledge and reality are created between the researcher and the participant and shaped by individual experience.

Greener (2008) describes interpretivism as a way to see the world through the eyes of the people being studied, allowing them multiple perspectives of reality. Interpretivism adopts the position that people's knowledge of reality is socially constructed and seeks meanings and motives behind people's actions, behaviours and interactions with others (Chowbury, 2014).

The study of social phenomena requires an understanding of the social worlds that people inhabit, which they have already interpreted by the meanings they produce as a necessary part of their everyday life together (Blalkie, 2015). The interpretivist paradigm acknowledges that people construct their own meaning of their experiences and knowledge generation happens when relevant insights emerge naturally through researcher and participant discourse (Coffey & Atkinson, 1996).

Interpretivism grew out of the philosophical traditions of Dilbey's hermeneutics and Husserl's phenomenology (Chowbury, 2014). Hermeneutics is the study of meaning and interpretation in historical contexts whereas phenomenologists advocate the need to consider human beings' subjective interpretations and perspectives of their life-worlds. Max Weber is the central influencing theorist who used the German term *Verstehen* to understand the intention and context of human action (Chowbury, 2014). Verstehen means to understand and perceive the nature and significance of a phenomenon (Martin, 2018).

Nunes and McPherson (2003) confirm that constructivism is a theory of learning that stems from the field of cognitive science, particularly the works of Piaget, Vygotsky, Bruner and Dewey. Dewey is considered to be the founder of social constructivism and he called for education to be grounded in real experience and evidence. Piaget postulated about children's processing of information and the mechanisms of assimilation and accommodation as key to this processing. Vygotsky developed the theory of the zone of proximal development. Vygotsky also suggested that students learn by doing, rather than observing. Bruner emphasised the role of the teacher, language and social interaction in learning (Bruner, 1996). The ontological assumptions of interpretivism are that social reality is seen by multiple people who interpret events differently.

The basic epistemological assumption of interpretivism is that people cannot be separated from their knowledge. According to Mack (2010), knowledge is gained through the subjective meaning of social action, is gained inductively to create a theory, is gained through personal experience and arises from particular situations. Denzin (2009) states that ways of knowing are always already partial, moral and political. Paradigms that assume a subjective ontology create a different type of knowledge because participants' experiences are considered for the new issues and the nuances, they highlight (Bunniss & Kelly, 2010).

Lin (1998) suggests that interpretative researchers often look for the presence (or absence) of a causal relationship but not in the same way as researchers working in the positivist paradigm who rely on statistical inference to claim causality. Interpretivist researchers instead inductively develop a theory or pattern of meanings through the research process (MacKenzie & Knipe, 2006). Meaning is constructed in a social and cultural context, through action and discourse (Young & Collin, 2004). Hill and McGowan (1999) consider that interpretative research may best be done using in-depth interviewing, observation, case-studies and the collection and analysis of documentation over a period of time.

3.5.3 Criticisms/Limitations of Interpretivism

Mack (2010) described some limitations to interpretivist research as follows:

- Outcomes of the research may not be transferable to other contexts/situations as the data may be heavily impacted by personal viewpoints and values;
- There may be bias from the researcher due to the subjective nature of the research;
- The data has a high level of validity but a low level of reliability.

Triangulation in researching the social world is recommended by some researchers to improve validity, reliability and generalisability (Silverman, 2004). Complementary methods of data collection may assist with research legitimisation. Hamersley and Atkinson (1983) suggest that the reliability of qualitative research findings may be improved by combining participant observation with interviews and documentary sources. To improve validity, use of multiple data sources is recommended in order to establish an identifiable chain of evidence and member checking with key informants (Remenyi, et al., 1998).

3.5.4 Axiology of Interpretivism

The basic ethos behind the interpretative epistemology necessitates the researcher's direct involvement in all stages of the research process (Kelliher, 2005). Researchers position themselves in the research and interpret what they find in light of their own experiences and background. Walsham (1995) claims that researchers use their own preconceptions to guide the process of inquiry and interacts with the human participants, changing the perceptions of both parties. Yin (1994) states that researchers are pre-disposed to factors of perception and prior expert knowledge, all of which influence what is taken to be factual information. Researchers must acknowledge that the research is value-laden and that biases are likely to be present.

The lens through which the present research was designed and interpreted is as a researcher deeply involved with the validation and accreditation processes and the participants contributing to the research. While this positioning has the advantage of allowing the researcher to bring considerable experience and insights to bear on the data collection and analysis, it also presents some challenges and necessitates careful consideration of objectivity and minimisation of bias.

3.6 Grounded Theory

3.6.1 Grounded Theory

Goulding (1999) states that within the Interpretivist paradigm there are numerous methodologies for constructing knowledge, each of which have their own underlying philosophies, practices and methods of interpretation. Grounded theory is one such methodology. Grounded theory was developed for, and is particularly suited to, the study of behaviour which has an interaction element to it and grounded in the words of the people under study (Goulding, 2005). The emphasis is on new theory generation in areas where little is already known or to provide a fresh slant on existing knowledge (Goulding, 1999).

A theory is a set of relationships that offers a plausible explanation of the phenomenon under study (Strauss & Corbin, 1994). Engward (2013) argues that in grounded theory the chosen data collection and analysis methods must be the most relevant to answer the research question. He further suggests that the researcher is required to enter the worlds of those under study in order to observe the participant's environment and the interactions that occur.

Goulding (1999) supports the view that grounded theory follows an interpretivist philosophy with its emphasis on multiple realities, the researcher and phenomenon are mutually interactive, the outcome of research is socially constructed and inquiry is always context-bound. Weed (2009) agrees that the ontological assumption in grounded theory is that multiple realities are constructed by individuals and that knowledge is developed through a process of interpretation. Mills et al., (2006) agree with Weed and Goulding that grounded theory may utilise a constructivist ontology and an interpretivist epistemology.

The grounded theory approach was first articulated by Glaser & Strauss as an empirical approach for developing theory (Glaser & Strauss, 1967). Over time Glaser and Strauss diverged in their ways of viewing grounded theory. Strauss stressed the interpretative, contextual and emergent nature of theory development while Glaser used highly complex and systematic coding techniques (Goulding, 1999). Over time three variations of grounded theory have emerged. These are Classical, Evolved and Constructivist and they exist on a methodological spectrum that reflects their epistemological underpinnings. Classical grounded theory reflects a positivist ontology and a realist epistemology. Evolved grounded theory reflects a relativist ontological position and interpretative epistemology (Weed, 2009). Constructivist grounded theory embraces a constructivist ontological position and an interpretative epistemology (Weed, 2009).

3.6.2 Constructivist Grounded Theory

Constructivist grounded theory actively positions the researcher as the author of a reconstruction of experience and meaning (Weed, 2009). The first researcher to describe her work as constructivist grounded theory was Charmaz. However, Bryant, Mills, Bonner and Francis are also accredited with founding and further developing constructivist grounded theory (Thornberg, 2012). Constructivist grounded theory is a popular method for research studies primarily in the disciplines of education, nursing and medicine (Mills, et al., 2006).

Charmaz (2006) defined constructivist grounded theory as rooted in pragmatist epistemology where data is co-constructed by researcher and participants and coloured by the researcher's perspectives. It assumes multiple realities. Prior knowledge and theoretical preconceptions are valuable and should be subjected to scrutiny. This brings to the fore the notion of the researcher as the author of the research. Researchers need to immerse themselves in the data but keep the participants' voice present in the research outcome (Charmaz, 2001).

There are core characteristics common to all variants of grounded theory as put forward by Weed (2009) and McCann & Clarke (2003b) as follows:

- An iterative research process;
- Treatment of the literature;
- Theoretical sampling;
- Theoretical sensitivity;
- Codes, memos, concepts;
- Constant comparison method;
- Theoretical saturation.

Each of these core characteristics is elaborated on in the following section.

3.6.3 Data Collection and Analysis using Constructivist Grounded Theory

Turner (2014) and Duan (2011) suggest that grounded theory can utilise both qualitative and quantitative data collection methods. The theory evolves during the research process itself and is a product of continuous interactive interplay between data collection and analysis of that data. Interviews and focus groups can be conducted more than once during the grounded theory building process (Elliott & Higgins, 2013).

The data analysis phase of the research starts with the breaking down of the data into separate units of meaning using codes (Moghaddam, 2006). Weed (2009) proposes that once the analysis has developed beyond initial stages, the constant comparison between data, codes, concepts and literature is a way of checking that the emergent insights are grounded in all parts of the analysis. Grounded theory sampling is purposive where the researcher will go to the most likely participants in search of information to support theory building – thus it is described as theoretical sampling (Coyle, 1997). Weed (2009) defines theoretical saturation as the point in the study when fresh data no longer provides fresh insights. Theoretical saturation and consensus achievement between experts are similar concepts as explained in the Delphi technique section of this chapter.

Mills et al., (2006) describe theoretical sensitivity as a concept of three parts, the researcher's level of insight into the research area, how attuned the researcher is to the nuances and complexity of the participant's words and actions and the researcher's ability to reconstruct meaning from the data generated. Glaser (2004) and Kelliher (2005) maintains that researchers should keep memos or reflective journals as theoretical notes about the data and the conceptual connections between categories.

In the present study, these activities were documented in a reflective journal that provided an audit trail as well as researcher interpretations of these events and findings.

3.6.4 Criticisms/Limitations of Grounded Theory

Goulding (2005) observed that the theoretical saturation of data timescale is difficult to predict. Other researchers have put forward concerns including:

- How closely concepts fit the phenomena they represent;
- Transferability of research outcomes is likely to be limited.

The methodology used to determine when consensus (theoretical saturation) was reached is explained and applied in chapters five, six and seven.

3.6.5 Constructivist Grounded Theory in this Research

Grounded theory is a methodology used to study behaviour with an interactive element which is appropriate for the research question. As the research seeks to create a fresh slant on existing knowledge, it is compatible with the aims of grounded theory. Other reasons why grounded theory is a suitable methodology for this research are as follows:

- Grounded theory is grounded in the words of the stakeholders of a phenomenon;
- Constructivist grounded theory follows a subjective ontology and an interpretative epistemology;
- Knowledge and theory are developed by a process of interpretation and induction;
- Data are co-constructed by the researcher and participants;
- Both quantitative and qualitative research methods can be used;
- More than one round of interviews can be accommodated;
- Purposive sampling from HEI and professional association staff who have expertise and experience of the programmatic review and accreditation processes can be arranged;
- The researcher has considerable experience of implementing the quality assurance processes.

3.7 Research Methods

3.7.1 The Delphi Technique

The Delphi method or Delphi technique is a structured method, originally developed as a systematic, interactive forecasting method which relies on a panel of experts (Iqbal & Pipon-Young, 2009). The Delphi technique is described by Keeney et al (2001) as:

'an approach used to gain consensus among a panel of experts. This is normally achieved through a series of rounds where information is fed back to panel members using questionnaires. It has been used extensively within social science research.'

The Delphi technique was founded in the 1950s by the RAND Corporation, USA. It is a flexible iterative process utilising the judgement of experts. It provides a way of obtaining a collective view from individuals about issues where there is little evidence or where opinion is important. The process can engender group ownership and enable cohesion among individuals with diverse views (Thangaratinam & Redman, 2005).

The Delphi technique was named after the ancient Greek oracle, who could predict the future (Thangaratinam & Redman, 2005). This technique is used to investigate what does not exist or to explore new concepts. The method is often applied to problems which would benefit from the subjective judgement of individuals, on a collective basis (Skulmoski, et al., 2007). The Delphi technique is used to achieve consensus through using a structured process to determine and explore group attitudes, judgements, needs and priorities. The process continues until group consensus is reached.

Iqbal & Pipon-Young (2009) suggest that the Delphi technique has its own distinct characteristics as follows:

- It uses a group of experts, specially selected for their particular knowledge on a topic;
- It is often conducted across a series of two or more sequential questionnaires, known as 'rounds';
- It employs an initial idea generation stage where the experts are asked to identify the range of salient issues;
- It collates ideas from round 1 to construct the survey instrument distributed in subsequent rounds;
- It has an evaluation phase (third or further rounds) where the experts are provided with the responses and asked to re-evaluate their original responses;
- It is interested in the formation or exploration of consensus.

The original Delphi technique used four rounds but this has been modified by many researchers to two or three rounds (adapted Delphi technique) as it is difficult to retain a high response rate when there are more than two rounds (Keeney, et al., 2001). Sumsion (1998) advocated that ideally a 70% response rate should be maintained. Online surveys assist in keeping the response rate high. Web services, such as surveymonkey.com, can be a simple way to conduct an online questionnaire (Iqbal & Pipon-Young, 2009).

The Delphi technique does not use a random sample representative of the target population but samples from experts in the area who have an interest or involvement with the question or issues being addressed (Keeney, et al., 2001). The selection of the expert panel is regarded as the lynchpin of the method and members are selected on the basis of their knowledge, expertise, experience and willingness to participate (Green, et al., 1999). The number of research participants varies from 10 to 50 mostly but is normally between 20 to 30 participants (Keeney, et al., 2001).

McKenna (1994) considers that when expert panel members are actively involved in the development of the research instrument, it leads to perceptions of ownership and acceptance of the findings. Goodman (1987) states that if panels participating in the study are representative of the group or the area of knowledge, then content validity can be assumed. The reliability of this research method has been found to be accurate in many studies but the selection of the expert panel members is critical to ensure the reliability and repeatability of achieving the same research outcomes.

Rowe and Wright (1999) have suggested that the benefits of the Delphi technique as a research method are:

- Participants can freely express opinions;
- Participants can refine opinions during the process;
- Controlled feedback allows participants to see other participants' perspectives.

Delphi technique results can be presented in many ways. This includes reporting items that have reached a pre-agreed level of consensus (Petry, et al., 2007), listing all items in order of consensus magnitude or also reporting those areas in which there is debate amongst the experts. The Delphi technique is regarded as a reasonable strategy for achieving consensus over curriculum needs (Thangaratinam & Redman, 2005).

3.7.2 Criticisms/Limitations of the Delphi Technique

One of the arguments against the Delphi technique is that these studies mostly overlook reliability measurement. Nevertheless, the findings in one study can be tested or confirmed in another study with a different sample as a means of validation (Thangaratinam & Redman, 2005).

A second criticism was raised by Skulmoski, et al. (2007), who cited many researchers as having difficulty generalising the results to a wider population due to sample size or the expert panel's limited views. According to Skulmoski et al. (2007), many researchers of Delphi technique research recommend further study to refine and verify their results or to investigate related research questions. The outcomes of this research compare favourably with an Engineers Ireland survey on a related topic (outlined in chapter two) with a different cohort of participants and will be discussed further in chapter eight.

3.7.3 Overview of the Delphi Method in this Research

The Delphi technique aims to achieve consensus through using a structured process. The data collection processes used in both grounded theory generation and the Delphi technique follow similar patterns where data collection and analysis proceeds in an iterative process until consensus/theoretical saturation is reached.

Round 1 usually begins with open-ended questions as part of a questionnaire. McKenna (1994) found that using face-to-face interviews in the first round increases the return rates of the questionnaire in the second round. Hence, interviews were used for the first round of data collection. A qualitative first round is optimal as the initial group of experts produces the research inputs (Hasson, et al., 2000). Hassan, et al. (2000) also suggest that a thirty minute first round interview is a reasonable time to gather the relevant information and strongly advocate that there should be an audit trail for reliability which includes a reflective journal.

Full details of the Delphi technique used in the present study are discussed in the next chapter and previewed here. The process of data collection involved interviews and questionnaires using an adapted Delphi technique methodology. A thirty-minute interview constituted round one followed by a questionnaire and then a final interview. The outcomes of the interviews informed the content of the questionnaire which in turn informed subsequent interviews. This approach is compatible with the development, triangulation and complementarity reasons for using mixed methods research published by Green et al. (1989). A reflective journal was also kept to capture the research decisions and the rationale for same during the data collection phase of the research.

The expert panel members were selected from the relevant stakeholders for the two quality assurance processes in engineering education. Gaining the insights of experts who have experience of the programmatic review and accreditation processes was intended to enhance the validity and reliability of the research outcomes.

3.8 Conclusion and Common Characteristics Across the Research Design

The theoretical framework for the research was determined via analysis of the philosophical aspects of the research question. The key features of the framework are:

- Pragmatic paradigm;
- Subjective ontology with multiple realities;
- Interpretative epistemology and axiology;
- Delphi technique data collection and using the constructivist grounded theory to support the analysis of the data.

Table 3.1 below highlights the common characteristics between the various elements of the research philosophy, denoted by the yellow colour in the table.

Common Characteristics	Pragmatism	Interpretivism	Grounded Theory	Delphi Technique
Subjective Ontology				
Multiple Realities				
Socially Constructed Knowledge				
Practical Outcomes				
Action and Change				
Qualitative and Quantitative Data				
Participant's Views				
Researcher's Views				
Co-constructed Data				
Iterative Process				
Consensus is Achieved				

Table 3.1: Common Characteristics Across the Research Design

The research focuses on the combination or alignment of the quality assurance processes in engineering education. In this chapter, the philosophy of this engineering education research has been examined. A rationale for the choice of theoretical framework for the research design has been provided, together with the consistent approach from paradigm selection through to data collection and analysis.

Chapter 4: Research Design and Implementation

4.1 Overview

As outlined in previous chapters, quality assurance of engineering education programmes in Ireland has evolved over time into two major assessment types, namely internal programmatic review and external accreditation. Other quality assurance measures are in place, including the external examiner system, but programmatic review and accreditation are considered to be the core quality assurance processes. These assessment types have emerged and are implemented worldwide for the quality assurance of engineering education programmes. Internal and external evaluation of programmes, in regular cycles, will continue to be part of the quality assurance processes.

The review of literature presented in chapter two has highlighted that these quality assurance appraisals are happening globally. The present study builds on this body of knowledge by determining if the internal programmatic review process can be brought into closer alignment with the external accreditation process, thereby creating the possibility of a single significant quality assurance process or facilitating both processes within the same timeframe.

To address this question, it was necessary to establish the views of the stakeholders to the possible combination or alignment of the programmatic review and accreditation processes for engineering education programmes in Ireland. These views should capture their perceived value and role of both processes. Comparing and contrasting the processes should highlight where stakeholders envisage that improvements may be made and determine if they consider that a combined or aligned processes is a worthwhile and valuable entity.

The purpose of this chapter is to describe and justify the research design and its implementation. The chapter content is organised into ten streams and follows the research design from the consultation phase in stream two, the research plan in stream three, ethical approval processes in stream four, development of the research questions for round one of the Delphi technique and focus group meetings in stream five, identification of research participants in stream six, setting up and conducting the round one interviews in stream seven, developing the questionnaire and carrying out the questionnaire survey in stream eight, setting up and conducting the round three Delphi technique interviews in stream nine, considering validity and reliability in stream ten and concludes with a summary of the research design.

4.2 Consultation with Gatekeepers

To inform the research design, it was necessary to establish the views of the primary stakeholders and gatekeepers to the possible alignment or convergence of the programmatic review and accreditation processes. HEIs are the primary gatekeepers of the programmatic review process, through their academic councils. Engineers Ireland is the primary gatekeeper to the accreditation process for engineering programmes in Ireland. QQI is responsible for the oversight of quality control in HEIs. The researcher's consultations in this stream of the chapter are organised by gatekeeper.

4.2.1 Consultation with the HEIs Via the Technological Higher Education Association (THEA)

The Technological Higher Education Association (THEA) is a collaborative group involving all the institutes of technology in Ireland. This group was established by the Presidents of the Institutes of Technology in the early noughties to promote collaboration and to provide a voice for the sector. THEA was formed to create a cohesive single advocacy body that supports the sector as it moves towards a planned reform of the higher education system that includes the creation of a series of technological universities. THEA works with its eleven member HEIs to shape and influence higher education policy directly with policymakers and other stakeholders (THEA, 2020).

THEA's mission is to increase awareness and understanding of the unique attributes of technological higher education in order to influence policy on behalf of its members. THEA provides secretariat services and facilitates the working agenda of various fora where all the Presidents, Registrars and other groups across the institutes of technology sector meet every two to three months. These regular meetings provide an opportunity to exchange information and learn from other members. The Council of Heads of School of Engineering and the Council of Registrars are two such groups that were consulted (THEA, 2020).

4.2.1.1 THEA Council of Heads of School of Engineering (CoHSE)

The Council of Heads of School of Engineering (CoHSE) has been established in the noughties. All the Heads of Faculty/School of Engineering from the institutes of technology sector are members of this Council.

Over many years, the CoHSE has expressed dissatisfaction with the twin processes of programmatic review and accreditation of engineering education programmes. Where the processes were once closely aligned, they began moving in different directions requiring different inputs, implementation and outputs. In addition, the complexity of the processes has increased significantly over time so that both processes are measuring the quality of engineering programmes using entirely different methodologies and absorbing huge amounts of staff and management time. Aligning of the programmatic review and accreditation processes has long been an ambition of the CoHSE.

At a CoHSE meeting in May 2015 I volunteered to create a draft position paper on behalf of the Heads of School of Engineering on the quality assurance processes in engineering education and the concerns and conflicts imposed on faculties/schools of engineering as a result of these processes. The content of the position paper included:

- Context of engineering education in institutes of technology;
- Quality assurance processes implemented (programmatic review and accreditation);
- The international dimension and other forms of accreditation;
- Concerns of the CoHSE.

The context, quality assurance processes and international influences were as discussed in chapter two of this thesis. Having both programmatic review and accreditation processes has led to the following CoHSE concerns agreed in the position paper:

- The requirements of the various professional associations with which CoHSE interact can be quite different. Some utilise the outcomes-based approach (Engineers Ireland) while others prefer to seek graduate competency (SCSI);
- The approach taken by different professional associations can vary, some involve a formal two day visit every five years, while others are more informal and based on a partnership model;
- As a sector, CoHSE have little influence over external bodies and managing them can be long term and time consuming. CoHSE should concentrate on what it can control;
- The financial cost of accreditation has become a significant financial burden to all institutes of technology;
- There are conflicting and competing interests involved so it may be difficult to make progress with this issue.

The first draft of the position paper was presented to the CoHSE on 6th October 2015. Further improvements were suggested at this meeting with an invitation to offer further reflections after the meeting. Taking all comments into consideration, a second draft of the position paper was prepared by the researcher and presented to the CoHSE on 4th February, 2016. It was agreed at this meeting that three members of CoHSE (including the researcher) would present this position paper to the THEA Council of Registrars at their next meeting.

4.2.1.2 Consultation with the THEA Council of Registrars

The THEA Council of Registrars (CoR) is similar to CoHSE in that all the Vice Presidents of Academic Affairs and Registrars from the Institute of Technology sector meet regularly to discuss common concerns. Three representatives of the CoHSE group presented the second draft of the position paper to the Council of Registrars at their meeting on 17th February 2016.

The Council of Registrars approved in principle the bringing into closer alignment of the programmatic review and accreditation processes but would need to see worked examples before full agreement would be forthcoming.

Further suggestions for improvement of the position paper from the Council of Registrars were captured in the third draft of the position paper as follows:

- A dialogue should be initiated with Engineers Ireland to explore how an enhanced alignment of the programmatic review and accreditation processes could be achieved and the mutual benefits of such an alignment;
- There should be a focus on the disconnection between programme re-structuring and re-accreditation. Programmatic review essentially looks forward in terms of programme design. In the case of Engineers Ireland, the accreditation process looks back at evidence produced in the past;
- Programmes that have been re-structured through the programmatic review process are often rolled out on a phased basis, so at any given time over the following two or three years, a combination of the old programme and new programme can be present and this can be confusing for accreditation panels.

4.2.2 Consultation with the Engineers Ireland Registrar

At the CoHSE meeting of 4th February 2016, it was agreed that the position paper would be presented to Engineers Ireland as it was the professional association that accredited most engineering programmes in the Institute of Technology sector. The Registrar of Engineers Ireland agreed to meet the same three CoHSE representatives on 11th May 2016. The issues raised at this meeting were substantially different from those mentioned by the Council of Registrars and a pathway forward emerged from the discussion.

It was agreed that a checklist between the activities involved in the programmatic review process and the Engineers Ireland accreditation process should be developed to identify common activities between the processes. Identifying the actions, responsibilities and challenges that would be needed to incorporate the Engineers Ireland accreditation process into the programmatic review process needed to be determined and captured in a second document.

4.2.3. Outcomes of Consultation with HEIs and Engineers Ireland

In response to the meetings with the registrar of Engineers Ireland and the THEA Council of Registrars, two new documents were created. The *Concerns and Challenges of Incorporating the Accreditation Process into the Programmatic Review Process* and the *Comparative Analysis Between the Processes* is summarised in this section of the chapter.

The Concerns and Challenges of Incorporating the Accreditation Process into the Programmatic Review Process document identified that the synchronisation of timelines between the programmatic review process and the accreditation process is critical. It also stated that the HEI programmatic review guidance documentation and Engineers Ireland guidance documentation should be merged. The site visit duration could be at least 2 days and should allow time for strategy considerations (looking forward) and the review of programme evidence (looking backward).

Other aspects of the processes considered during the consultation process included the application procedure, the assessment of engineering programmes against the Engineers Ireland accreditation criteria, overall responsibility to lie with the HEI’s Registrar and that the two processes are independent of each other in terms of outcome.

One of the main outcomes from the consultation process was that the merging of objectives set out by QQI/HEI's academic council and those set by the Engineers Ireland accreditation process should be considered to allow convergence of the processes.

The second outcome of the initial consultation with HEIs and Engineers Ireland was a comparison, in the form of a checklist, of the activities involved in the programmatic review process and the Engineers Ireland accreditation process to identify the common and the unique activities of both processes. A small sample of the checklist is given in Table 4.1 where the green areas of the checklist illustrate where the processes have similar procedures and the orange areas where the procedures differ. The full comparison document is given in Appendix A of this thesis.

Process Stage	Programmatic Review	Engineers Ireland Accreditation
Overview	Cyclical review every 5-7 years	Cyclical review every five years
Overview	Mandatory process	Voluntary process
Overview	Evaluates programme over previous five years and plans for the next five years	Evaluates programme over previous five years
Overview	Review by an independent panel	Review by an independent panel
Responsibility	HEI Registrar	Engineers Ireland Registrar
Objectives	Set by QQI and academic council	Set by Engineers Ireland
Self-Evaluation	Engagement with employers, graduates and students	Engagement with employers, graduates and students
Visit to HEI	Duration about 1.5 days	Duration 2 days
Visit to HEI	Agenda set by academic council	Agenda set by Engineers Ireland
Visit to HEI	Meetings with employers, graduates and students on the programmes	Meetings with employers, graduates and students on the programmes

Table 4.1: Comparison Checklist of the Quality Assurance Processes

These documents, as well as the position paper, were agreed by the COHSE at their meeting in May, 2017. The position paper concluded that there is considerable overlap between the programmatic review and accreditation processes and some realignment/amalgamation of the processes should achieve the same outcomes. The agreed position paper is given in Appendix B of this thesis.

Both the CoR and the Registrar of Engineers Ireland agreed in principle with the contents of the position paper and recommended further consultation with QQI.

4.2.4 Consultation with QQI

A meeting was arranged with the QQI Head of Stakeholder Engagement and Communications and the Head of Validation and Delegation in January 2018. The meeting was held to consider if QQI could support the alignment of the objectives of the programmatic review and the Engineers Ireland accreditation processes. At this meeting, QQI stated that they would not be averse to '*replacing the Engineering Award Standards with the Engineers Ireland Accreditation Criteria'*. This would have significant benefits to the academic engineering community as the same objectives could be used as the basis for the assessment of, and development of, engineering programmes. Working from the same set of objectives would naturally align the processes even if the focus and intent varied.

This development was discussed with the CoHSE group at their next meeting and they supported this concept enthusiastically. I then set up a tripartite meeting between QQI, Engineers Ireland and myself to determine if this concept could be further advanced between these gatekeepers.

4.2.4.1 Meeting between QQI and the Registrar of Engineers Ireland

The meeting was held in QQI offices, Dublin on 18th June 2018, to explore the possibility of aligning the Engineering Award Standards and the Engineers Ireland Accreditation Criteria. QQI were represented by the Director of Qualifications Directorate, the Head of Validation and Delegation and the Head of the Award Standards. Engineers Ireland was represented by the Registrar and I was present as the main driver of this initiative.

The discussion commenced with an outline of the research being carried out by the researcher and an overview of the consultation with the THEA groups and the Registrar of Engineers Ireland. The position paper and comparison checklist were examined and the cyclical review timescale for both processes were noted. The Engineers Ireland accreditation being informed by international engineering norms was emphasised. The role of the Professional Award Type Descriptors was mentioned. The purpose of each process and the similarity of language used between them was considered. It was noted that the Engineers Ireland accreditation criteria was due to be reviewed.

It was agreed in principle that the alignment process should be looked at further. A starting point was to be the triangulation of the QQI Engineering Award Standards, Professional Award Type Descriptors and the Engineers Ireland accreditation criteria.

The actions arising from the meeting required triangulation of the two sets of QQI standards and the Engineers Ireland accreditation criteria. If the objectives could be the same, then justification for combining the processes into a single process would be more reasonable. It was important to establish to what extent the process objectives were similar and what degree of modification would be required to make them similar.

4.2.4.2 Triangulation of the Quality Assurance Processes Objectives

I reviewed the Engineers Ireland accreditation criteria, the QQI Engineering Award Standards and the QQI Professional Award Type Descriptors. The *QQI Engineering Award Standards* are set out in terms of the knowledge, skills and competence learning outcomes to be acquired by learners before a higher education award can be made (QQI, 2014). The standards are based on the level indicators and award type descriptors of the NFQ. The standards are a reference point for the design of a programme in a specific field of engineering and are further divided into six sub-strands of mathematics, science, information technology, design and development, business context and engineering practice for each of the NFQ levels 6, 7, 8 and 9.

QQI has also published *Professional Award Type Descriptors* for the alignment of professional awards at NFQ levels 5, 6, 7, 8 and 9 which outline the typical uses to which the knowledge, skills and competence will be put (QQI, 2014).

The Engineers Ireland's *Accreditation Criteria and Professional Titles* document sets out separately the accreditation criteria which apply to engineering education programmes for the three professional titles of chartered engineer, associate engineer and engineering technician. The accreditation criteria are specified in terms of programme outcomes and programme area descriptors. There are six or seven programme outcomes and six programme area descriptors for each professional title (Engineers Ireland, 2014).

To enable comparison across the three documents, the following assumptions were made:

- NFQ level 6 equates to the level of the Engineering Technician professional title;
- NFQ level 7 equates to the level of the Associate Engineer professional title;
- NFQ levels 8 and 9 (combined) equates to the level of the Chartered Engineer title;
- The engineering award strands of knowledge, skill and competence, the professional award type descriptors and the Engineers Ireland programme outcomes were of a similar nature and could be directly compared;
- The engineering award sub-strands and the Engineers Ireland programme area descriptors are of a similar nature and could be directly compared;
- The Engineers Ireland discipline-specific technology programme area descriptor was incorporated into comparison tables were relevant and appropriate;
- The mathematics and science sub-strands were combined to provide a direct comparison with the sciences and mathematics programme area descriptor.

Twenty-four triangulation documents were prepared, comparing and contrasting the two QQI standards and the Engineers Ireland accreditation criteria. This allowed for comparison across the three engineering professional titles, their equivalent NFQ levels for the three strands of knowledge, skills and competence and the five sub-strands of mathematics and sciences, design and development, information technology, business context and engineering practice.

The comparison documents are two-dimensional tables where the engineering award standards are split into three columns showing strand, strand descriptor and standard expected. The professional award type descriptors are separated into two columns with the descriptor and the standard expected. The comparable accreditation programme outcomes are given in one column showing the standard expected and the reference link back to the exact subsection in the accreditation criteria document.

The twenty-four triangulation documents are as follows:

- Three documents for the level 6/Eng. Tech. award – knowledge, skills & competence;
- Three documents for the level 7/Associate Eng. award – knowledge, skills and competencies;
- Three documents for the levels 8 and 9/Chartered Eng. award – knowledge, skills and competencies;
- Five documents for the level 6/Eng. Tech. award for the programme area descriptors;
- Five documents for the level 7/Associate Eng. award for the programme area descriptors;
- Five documents for the levels 8 and 9/Chartered. Eng. award for the programme area descriptors.

The summarised Table 4.2 and Table 4.3 have been created to allow for the illustration of the objectives' comparison tables in this thesis and are a close match to the actual comparison documents. Table 4.2 shows a competence strand for the NFQ level 7/Associate Engineer professional title. Table 4.3 shows an engineering practice sub-strand for the NFQ levels 8 and 9/Chartered Engineer professional title.

The tables were summarised as they would be too large to present in this thesis document but a small sample of the actual tables are shown in Appendix C of this thesis. Appendix C gives the knowledge comparison table for the NFQ Level 6/Eng. Tech. professional title, the skills comparison table for the NFQ level 7/Associate Engineer professional title and the design and development comparison table for the levels 8 and 9/Chartered Engineer professional title.

Engineering Award Standards	Professional Award Type Descriptors	Accreditation Criteria Programme Outcomes
Context Using diagnostic and creative skills in a range of functions in a variety of contexts	*Exercising autonomy and judgement* Exercise autonomy and judgement in applying knowledge and skills in a wide variety of contexts including professional practice and study	*Associate Engineer Programme outcomes* (b), (c)(ii), (c)(iii), (c)(iv), (d), (d)(i), (d)(ii), (d)(iii), (d)(iv)
Role Accept accountability for determining and achieving personal and/or group outcomes; take significant or supervisory responsibility for the work of others in defined areas of work	*Exercising responsibility* Manage complex technical or professional activities or projects, taking responsibility for decision-making and decisions in unpredictable work or study contexts	*Associate Engineer Programme Outcomes* (c)(ii), (d)(ii), (e)
Role Accept accountability for determining and achieving personal and/or group outcomes; take significant or supervisory responsibility for the work of others in defined areas of work	*Working with others* Act effectively in team roles and take responsibility for managing individuals and groups	*Associate Engineer Programme Outcomes* (f), (f)(ii), (f)(iii), (f)(iv)
Learning to learn Take initiative to identify and address learning needs and interact effectively in a learning group	*Learning and teaching* Take initiative to identify and address learning needs; seek necessary guidance when working independently	*Associate Engineer Programme Outcomes* (f), (f)(i), (f)(iii)
Insight Express an internalised, personal worldview, manifesting solidarity with others	*Attitudes* Express an internalised, personal worldview, manifesting solidarity with others at all levels including the personal, professional, societal and environmental	*Associate Engineer Programme Outcomes* (e), (f), (g)

Table 4.2: Competence Comparison Table for the NFQ level 7/Associate Engineer Professional Title

Engineering Award Standard	Engineering Award Sub-strand	Accreditation Programme Area Descriptor
Knowledge breadth	Knowledge of current engineering practice	Familiarity with engineering operational practice
Knowledge kind	Engineer's role in society and ethical standards	Awareness of codes of practice and ethical standards
Skill know how and skill range	Perform a management role in an engineering context	Day to day management of complex engineering projects
Skill know how and skill selectivity	Apply principles to real engineering problems	Control engineering products or processes

Table 4.3: Engineering Practice Comparison Table for the NFQ levels 8 and 9/Chartered Engineer Professional Title

Even though there are differences in wording between the standards/criteria and based on the assumptions made, it has emerged that there is a level of agreement between all the documentation of over 90% in terms of intent.

4.2.4.3 QQI Engagement with Professional Associations and HEIs

The triangulation comparison tables were discussed with the QQI Head of Research and Standards on 30th January 2019, who agreed to review same on a confidential basis. The Engineering Award Standards are QQI interpretation /translation of the NFQ levels.

At the time QQI were preparing legislation to review the programmatic review processes and allow HEIs to become designated awarding bodies. This means that QQI would no longer have a role in managing the internal quality assurance processes in HEIs with designated award body powers. All institutes of technology became designated awarding bodies on January 1st 2020. The emphasis is for all HEIs to separately set their programme standards to be consistent with the NFQ. In reality, from January 1st 2020, most HEIs adopted the QQI standards as their academic council standards for making awards at NFQ levels 6-9. In addition, Engineers Ireland revise their accreditation criteria regularly.

It was agreed at this meeting that further engagement on this topic would require a broadening of stakeholders to include QQI, Engineers Ireland and other professional and regulatory bodies, HEI representatives including Registrars and Heads of Faculty/School.

QQI organised a conference in Dublin on 19th June 2019, titled *'Finding Common Ground on Professional Accreditation and Regulation.'* I gave a presentation on '*Mapping Professional Body Practice and Collaborative Projects*' at this conference, highlighting the level of agreement in excess of ninety percent between the QQI standards and Engineers Ireland accreditation criteria. Over 150 educational specialists in the professional and regulatory association sphere, as well as academics and government agencies attended this conference. At the end of the presentation, the QQI conference manager questioned the audience on whether they would be interested in continuing with the concept of bringing the quality assurance processes into closer alignment and there was strong agreement to do so by all who were present. This presentation is published on the QQI website.

I was asked to present a paper at the Engineers Ireland Engineering Education Conference '*Engineering Education: Future Skills, Standards and Mobility'* on 30th October 2019, as a consequence of my presentation at the QQI conference in June. The presentation was titled '*Accreditation and Graduate Mobility: The Alignment of the Accreditation and Programmatic Review Processes in Engineering Education'*. There followed an invitation to produce a conference paper which was subsequently published in the Engineers Journal in November 2019, and can be found at http://www.engineersjournal.ie/2019/12/02/conference-generates-insights-on-future-of-engineering-education/. The conference paper can be found in Appendix D of this thesis.

After the conference in June 2019, QQI continued to coordinate a programme of engagement with the professional statutory and regulatory associations. The main objective of this engagement was to reduce the burden of accreditation on HEIs. As part of this, QQI has facilitated meetings between the HEIs and professional associations, and also met regularly with Engineers Ireland to progress this ambition further.

In December 2019, QQI held a meeting with professional statutory and regulatory associations and HEIs at which a set of principles in respect of accreditation, produced jointly by Professions Australia and Universities Australia, was discussed. The Australian bodies have been successful in bringing HEIs and professional associations closer together by ensuring the accreditation activities are clear, transparent and cognisant of other HEI responsibilities and quality assurance activities.

With the permission of the Australian bodies, QQI has created a set of Irish principles titled '*Towards Principles for Accreditation and other Professional Engagements'*. The Irish principles emphasise the publication of accreditation reports, sharing of quality assurance documentation and reports, implements procedures for conflict of interest and gives consideration to resources, policies and practices. Stakeholders are liaising with QQI on the agreement of Irish accreditation principles.

4.3 Research Design

4.3.1 Evolving Research Design

In Chapter 3, the theoretical framework for this research determined that constructivist grounded theory and the Delphi technique would be used for data collection and analysis. An adapted Delphi technique would be implemented where the first round would be a qualitative interview. The literature highlighted that ideally the round one interview should be of thirty minutes duration with the expert research participants. To maximise research participation by the experts, their entire contribution to the research should be limited to sixty minutes duration (Hasson, et al., 2000).

Using open-ended questions allows the research participant the space to express meaning in their own words (Green, et al., 2009). As this is consistent with the theoretical framework of the research, semi-structured interviews were conducted for rounds one and three. To follow the classical Delphi technique and to ensure controlled feedback to the participants, a quantitative questionnaire was administered in round two and the subsequent outcome was used for round three. Rounds two and three were to be of fifteen minutes duration each to ensure an overall research participant contribution of sixty minutes. The implementation methodology for each of the rounds will be discussed in Streams 4.7, 4.8 and 4.9.

Sampling was very purposive from a pre-determined expert group who have the knowledge and experience of both target quality assurance processes. This form of sampling is consistent with the Delphi technique and is discussed further in Stream 4.6 of this chapter. Sampling for the focus groups was also very purposive and consistent with the Delphi technique but from a different cohort of participants. The participants for the Delphi technique element of the research and the focus group element of the research were mutually exclusive because the researcher wished to minimise any power influences in the Delphi technique research. The LIT staff were only invited to participate in the focus group meetings.

The round one interview questions were initially generated from the outcomes of the consultation process which were the *comparison checklist for the quality assurance processes* document and the *concerns and challenges of incorporating the accreditation process into the programmatic review process* document. The selection of the interview questions is further discussed in Stream 4.5 of this chapter. A pilot focus group meeting and a focus group meeting were utilised to further refine the interview questions. The final set of interview questions, for round one, emerged after consultation with the research supervisors and checking for phraseology and bias.

4.3.2 Research Plan

Table 4.4 sets out, in summary form, the research plan for this study.

Research Design & Implementation	Outputs	Timeline
Consultation process – CoHSE, CoR, Engineers Ireland, QQI	Comparison checklist Concerns and Challenges document	October 2015 - ongoing
Apply for ethical approval from UL and LIT	UL – EHSREC ethical approval LIT – REC ethical approval	Nov 2016 – Feb 2017 March 2017 – May 2017 Further information to Feb 2019
Identify the research participants	Initial participant lists for the Delphi research and focus groups	March 2017 - Sept 2017
Develop questions and hold focus group meetings	Revised set of the first-round questions. Pilot focus group meeting and focus group meeting	May 2017 – Sept 2017
Delphi round one implementation and analysis	Semi-structured interview responses and analysis	Oct 2017 – Dec 2018
Delphi round two implementation and analysis	Questionnaire responses and analysis	Jan 2019 – Oct 2019
Delphi round three implementation and analysis	Semi-structured interview responses and analysis	Nov 2019 – June 2020
Write up of thesis	PhD Thesis document	Aug 2020 – Feb. 2021

Table 4.4: Research Design and Implementation Plan

This research is conducted under the School of Education, University of Limerick, and thus ethical approval was sought from the University of Limerick. In addition, some of the research participants were staff from Limerick Institute of Technology. Under Limerick Institute of Technology's research regulations and procedures, research involving any of its staff requires ethical approval from its research ethics committee and ultimately academic council. Therefore, ethical approval for this research was additionally sought from Limerick Institute of Technology as outlined in Stream 4.4 of this chapter.

4.4 Ethical Approval for this Research

4.4.1 Ethical Issues

For any research conducted with human participants, it is imperative to develop an ethical protocol for the research, which should be submitted to the relevant research ethics committee for approval before any contact with the human participants commence. Brinkman and Kvale (2015) suggest that the ethics protocol should address beneficence and non-maleficence, informed consent, confidentiality and the role of the researcher.

4.4.1.1 Beneficence and Non-Maleficence

Green, et al. (2009) explain that beneficence requires researchers to assess and balance the benefits and risks for participants to partake in a research project. According to Seidman (1998), researchers must consider what steps they can take to reduce the threat of exploiting their participants or somehow injuring their dignity. Any risks the participants may be taking by being involved in the research need to be identified, and assessed and mitigation measures put in place, where possible. Measures to minimise consequences for participants in this research included:

- Providing the participants with information about the study topic and the research;
- Providing the participants with information about their contribution to the research. This includes information about how the research would be conducted (three rounds of interviews/questionnaire) and the timelines needed for their contribution;
- Informing them about how the study may benefit them if a combined or aligned process emerges from the research;

- Informing them how the confidentiality of the participants would be protected by keeping interview data in a secure place and by using codes to describe participants in the study. Participants were assured that the researcher would not discuss any names or identifying particulars of the research participants with any third party;
- Transcription of the interviews was to be done with full confidentiality. All transcription data was to be returned to the researcher at the end of the transcription process;
- Using code names to disguise the participant's real names to ensure anonymity of the participants when the research is published;
- Destroying the research data at the end of the research archiving period (normally seven years after data collection).

4.4.1.2 Informed Consent

It is both ethically and methodologically desirable to seek informed consent from all participants to a research project. The main ethical concerns of research with human participants involves ensuring that they provide voluntary informed consent for their participation in the research. Green, et al. (2009) describe informed consent as providing the participant with adequate information and sufficient time to make a reflective voluntary decision. Informed consent entails informing the participant about the overall purpose of the investigation, the main features of the design and any possible risks and benefits from participation in the research project. Obtaining informed consent minimises any misunderstandings as to the nature and dissemination of the research outputs. The information obtained should not be recorded in such a manner that human subjects can be identified (Seidman, 1998).

For this research a *Research Information Letter* and *Consent Form* were prepared which included details of:

- The identity of the researcher;
- The nature of the research, its aim and question;
- The university contact for information if the participant had an issue with the research process;
- Any risks and mitigating measures as outlined in section 4.4.1.1 of this thesis;
- The voluntary nature of participation in the research;

- The participant's right to review their research data and to withdraw from the research without consequence at any time;
- How the participant's names would be changed in the published reports to disguise their identity;
- How the research output would be disseminated;
- When the research data would be destroyed.

Prospective participants were asked to sign the consent form before participating in the research and the researcher spoke individually to them prior to their signing of the consent form to explain the information it contained. At least two weeks were allocated for participant reflection following receipt of the research information letter and consent form. Non-response from a potential participant indicated that they did not wish to participate in the research and no further contact was made.

4.4.1.3 Confidentiality and Anonymity

Confidentiality includes an agreement with participants about what may be done with the data that arises from their participation in the research (Brinkmann & Kvale, 2015). Normally, all expert Delphi panel members remain anonymous and their identity is not revealed. Goodman (1987) states that anonymity provides an equal chance for each panel member to present and react to ideas unbiased by the identities of the other participants. There is no way of knowing whether the nominated individual is the person who completed the questionnaire or whether it has been the focus of discussion with other individuals (Keeney, et al., 2001). The following measures to ensure confidentiality and anonymity of participants' personal information were taken:

- Participants were informed as to how the confidentiality of their identities would be protected by keeping interview data in a secure place and by using codes to describe participants in the study. They were assured that neither their names nor identifying particulars would be discussed with any third party;
- Transcription of the research interview was done with full confidentiality. All transcription tapes and any other data were returned to the researcher at the end of the transcription process. Transcriptions remained in the direct physical possession of the researcher;

- Code names were used to disguise the participants' real names to ensure anonymity of the participants when the research is published;
- The research data was to be destroyed at the end of the research archiving period.

4.4.1.4 Role of the Researcher

Brinkman and Kvale (2015) claim that the closeness of the research relationship puts strong demands on the tact of the researcher regarding how far to go in their enquiries. The majority of the participants were known to the researcher as work colleagues from other institutes of technology and universities in Ireland. LIT work colleagues of the researcher only participated in the focus group meetings. Balancing the formal role of the researcher with the normal social interaction between the researcher and participant was carefully managed by the researcher.

4.4.2 Ethical Approval for this Research

Ethical approval for this research involved two separate processes. An application for ethical approval was submitted to the University of Limerick (UL) Education and Health Sciences Research Ethics Committee (EHSREC) and an application for ethical approval was submitted to the Limerick Institute of Technology (LIT) Research Ethics Committee.

Both approvals were necessary as the researcher conducted this research as a postgraduate student in the Faculty of Education and Health Sciences in UL and the researcher also held focus group meetings with LIT staff.

4.4.2.1 Research Information Letters

Two research information letters were prepared for the commencement of this research. One letter was intended for the Delphi research participants and one letter was intended for the focus group participants. Both letters held similar general information but differed in relation to the research contribution required of the participants. Two further research information letters were sent to participants at the commencement of the Delphi rounds two and three of the research. The Delphi rounds one, two and three information letters are given in Appendix E of this thesis.

4.4.2.2 Consent Forms

Two consent forms were prepared for the commencement of this research. One consent form was intended for the Delphi research participants and one consent form was intended for the focus group participants. Both consent forms held similar information but differed in relation to the research contribution required of the participants. The Delphi research consent form is given in Appendix E of this thesis.

4.4.3 Application for Ethical Approval to the University of Limerick

The application for ethical approval of the research was approved by the UL Research Ethics Committee on 19th December 2016 subject to two minor amendments. The researcher made the requested amendments and resubmitted the revised ethical application to the secretary of the EHSREC on 20th February 2017. The secretary provided the EHSREC response on 23rd February (via email) to the resubmission confirming that ethical approval had been given for the research. The researcher is required to complete a Research Completion Report Form on completion of this research. The EHSREC confirmation of ethical approval email is given in Appendix F of this thesis.

4.4.4 Application for Ethical Approval to the Limerick Institute of Technology

As the research involved LIT staff in the focus group phase, the researcher also applied for ethical approval from LIT. A completed application for ethical approval was submitted to the LIT Research Ethics Committee in March 2017. The confirmation of ethical approval was communicated to the researcher in May 2017 subject to the submission of the interview questions and questionnaire for the Delphi rounds one and two when drafted for review. The Delphi round one questions were submitted to the LIT Research Ethics Committee in October 2017 and approved without modification in December 2017. The Delphi round two questionnaire was submitted to the LIT Research Ethics Committee on 1st February 2018, and approved without modification on 26th March 2018. The three LIT Research Ethics Committee confirmation of ethical approval letters are provided in Appendix F of this thesis.

4.5 Generation of the Delphi Round One Interview Questions

The approach taken for the remainder of this chapter is to provide the information in chronological order as each round of the Delphi technique is connected to the subsequent round, and dependent on the previous round. Initially the Delphi round one interview questions are finalised, then the research participants are identified. The subsequent three streams outline how the three rounds of the Delphi technique were implemented. Consideration of validity and reliability follow together with the chapter conclusion.

4.5.1 Initial Generation of the Delphi Round One Interview Questions from the Consultation Process

Following consultation with the CoHSE, CoR, Engineers Ireland Registrar and QQI, two documents were prepared. The *comparative analysis checklist between the two quality assurance processes* document and *the concerns and challenges of incorporating the accreditation process into the programmatic review process* document are outlined in Section 4.2.3 of this thesis. The initial generation of questions came directly from the considerations mentioned in these documents.

This initial set of Delphi round one interview questions were presented as a *Script of Focus Group Questions* which were added to the ethical approval applications for the research in UL and LIT. The respective Research Ethics Committees in UL and LIT approved these questions for the focus group meetings. The comparison analysis checklist was also approved as part of the script of focus group questions.

Table 4.5 provides the original list of questions for the Delphi round one interviews. These questions were reviewed at the focus group meetings and with the research supervisors. The final list of questions will be presented later in this chapter.

Question Number	Original Round One Interview Questions
1	What do you think of the concept of combining the programmatic review and accreditation processes into one quality assurance process?
2	What are the likely benefits to combining the two processes into one process?

3	What are the likely problems to be encountered as a result of combining the two processes?
4	Does the comparative analysis of the two processes capture all the areas of similarity and difference?
5	Are there parts of either process that are likely to disrupt the combining of both processes?
6	Who do you think are the main players in the programmatic review process?
7	Who do you think are the main players in the engineering accreditation process?
8	Should the accreditation process be an element of the programmatic review process or vice versa?
9	Is it likely that the cyclical cycles of the programmatic review and accreditation processes can be synchronised?
10	How would you merge the programmatic review and Engineers Ireland documentation requirements?
11	How would you maintain the voluntary nature of the accreditation process if both systems are combined?
12	How would you adjust the duration of the site visit to allow for the combined programmatic review/accreditation process elements?
13	How would you change the agenda to allow for the combined programmatic review/accreditation process?
14	How could the commencement be triggered for the combined programmatic review and accreditation processes while allowing for professional body procedures?
15	How would you include the assessment of the Engineers Ireland accreditation criteria by the evidence-based methodology into the programmatic review process or vice versa?
16	How would you include the evidence-based objectives of the Engineers Ireland accreditation process into the programmatic review objectives or vice versa?
17	Overall responsibility for the programmatic review lies with the Institutes academic council, through the Registrar’s office. Overall responsibility for the Engineers Ireland accreditation process lies with the Engineers Ireland Registrar. How will the responsibility for these processes be managed in the combined scenario?
18	Engineers Ireland charges the Institutes of Technology a substantial fee to provide the accreditation process for their engineering programmes. How could this be managed in light of the combined scenario?

19	How will communication be managed between the final programmatic review report and the Engineers Ireland accreditation board?
20	How will academic council documentation be altered to include the Engineers Ireland accreditation criteria?
21	The two quality assurance processes have independent outcomes. How can these independent outcomes be maintained?
22	What changes to the faculty, department and programme documentation will be needed to support the combining of the processes?
23	What should be the composition of the internal/external review panels for the combined site visit and how should this be modified to manage the evidence-based aspects of the combined processes?
24	Should the final external panel report have separate elements for the programmatic review process and the accreditation process and what should these separate parts look like?
25	How would communication be managed between the faculty/department, Institute Registrar's office and the Engineers Ireland Registrar?

Table 4.5: Original Delphi Round One Interview Questions

4.5.2 Focus Group Pilot Meeting

The purpose of the focus group pilot meeting was to garner views on the proposed focus group process and the questions to be asked at the focus group meeting. It was of sixty minutes duration. Four participants were selected and three of the invitees attended the event. The criteria for the selection of these participants was that they were LIT staff members, they had experience of participating in the accreditation and programmatic review processes and of being an external accreditation panel member and that they had experience of supervising major research projects with focus group elements.

Invitations were initially issued verbally and if accepted an email was sent with the meeting details, the purpose of the event, the research study focusses and the comparative analysis document. The focus group pilot meeting was held on 29th May 2017 in a neutral venue for all the participants. Microsoft Power Point slides were used to inform the participants about the study and to review each interview question in turn. Twenty-five potential questions were reviewed during this meeting. A selection of the PowerPoint presentation slides for the focus group pilot meeting are shown in Appendix G of this thesis.

4.5.2.1 Focus Group Pilot Meeting Notes and Suggested Changes

Each of the twenty-five potential questions were considered in turn and suggestions noted at the focus group pilot meeting. In addition, some overall suggestions were put forward at the meeting as follows:

- All twenty-five questions should be laid out on a table to search for a thread going through some of the questions;
- What are the key questions to be answered?
- There are too many questions – endeavour to have 12 to 15 questions;
- Use of diagrams or pictures in the presentation slides would assist;
- Emphasise the potential outcome of the research.

The full set of focus group pilot notes is given in Appendix G of this thesis.

4.5.3 Changes to Research Questions following the Focus Group Pilot Meeting

There were substantial changes to the potential questions suggested at the focus group pilot meeting. Minor changes were made to a number of questions. Some of the presentation slides content was amended and some irrelevant presentation slides were removed. All changes were made by 10th June 2017. A new presentation slide on the focus group meeting process was inserted to provide clear ground rules on the conduct of the meeting, to mitigate the power dynamic and to assure confidentiality. The original 25 questions were altered in accordance to the notes taken at the meeting which mainly consisted of adding prompts, removing duplication and removing questions which would be better posed in the round two questionnaire.

4.5.4 Focus Group Meeting

The purpose of the focus group meeting was to garner views on the research process used and the questions to be asked at the Delphi round one in-depth semi-structured interview stage. The meeting time was limited to sixty minutes. The initial proposed focus group questions were amended and reduced in number as a result of the focus group pilot meeting and then presented to the focus group meeting.

Fifteen participants were selected according to the ethical approval of this research. Eleven of the invitees attended the event.

The criteria for the selection of these participants was as follows:

- LIT staff from the three engineering disciplines – civil, electrical, mechanical;
- Had experience of managing/participating in the accreditation and/or programmatic review processes;
- Had experience of being an external accreditation panel member with Engineers Ireland in some instances;
- Roles and responsibilities varied including the VP Academic Affairs and Registrar, Head of Faculty, Head of Department, Senior Lecturer, Lecturer and Technician;
- Had not participated in the focus group pilot meeting.

The researcher prepared for the focus group meeting by sending the prospective participants, a Research Information Letter and Consent Form, as per ethical approval from UL and LIT. When completed consent forms were received, an email was sent with a reminder of the meeting details, the purpose of the event and the comparative analysis document. An opening statement was prepared in the form of a Microsoft Power Point presentation. The focus group meeting was held on 16th June 2017 in a neutral venue for all the participants. Power Point slides (a selection of the slides is given in Appendix H) were used to inform the participants about the study and to review each interview question in turn. Fourteen questions were reviewed at the focus group meeting.

4.5.4.1 Focus Group Meeting Notes and Suggested Changes

Each of the fourteen potential questions were considered in turn and suggestions noted at the focus group meeting. In addition, some overall suggestions were put forward at the meeting. The focus group meeting participants suggested that adding a few general questions at the start of the interview could establish the participants knowledge of the programmatic review and accreditation processes, their perspectives of the processes whether negative or positive and whether the participants value the processes. The selection of accreditation and validation panel members was considered and the focus group members noted that HEIs only have control over the selection of panel members for the programmatic review process. It was envisaged that some questions should be more contained and part closed. It was acknowledged that the accreditation process has strong international recognition. The full set of focus group meeting notes is given in Appendix H of this thesis.

4.5.5 Changes to Research Questions following the Focus Group Meeting

Minor changes were made to a number of the Microsoft Power Point presentation slides and some slides were removed. Four additional questions were added to the start of the interview questions to establish the participant's knowledge of the programmatic review and accreditation processes and their overarching perspective of them (positive or negative). All changes were made by 20th June 2017. At the end of this process there were seventeen questions for the round one interviews.

4.5.6 Meeting with Research Supervisors

At a meeting with the research supervisors on 29th June 2017, the outcome of the focus group meeting was discussed and the revised questions were reviewed in turn. Suggestions for improvement for some of the questions were agreed. A discussion around producing different but overlapping questions for three organisational levels led to agreement on a three or four level division of questions depending on whether students could make a practical contribution to this research.

The agreed three/four level division of questions were as follows:

- Governance/Policy level;
- Management level;
- Lecturing staff level;
- Student level.

4.5.7 Changes to Research Questions following the Meeting with the Research Supervisors

Further reflection led to the establishment of four sets of interview question being prepared with high degrees of overlap between the questions as follows:

1. Governance Policy Group – 70% overlap with the Management Group questions
2. Management Group – All questions
3. Lecturing Staff – All questions – 100% overlap with the Management Group questions
4. Students – 50% overlap with the Management Group questions.

Minor changes were made to a number of the focus group meeting questions and an additional catch-all question was added at the end of the interview to allow participants the opportunity to express opinions not sought in the other questions.

Information on ground rules, ethics and confidentiality were added to the presentation before moving on to ask the prepared questions. Interviews were to be recorded by using an electronic recording device, whenever possible, to ensure the validity of the data. The choice of whether the interviewee wished to be recorded in this way was clearly set out at the commencement of the interview. The participant was given an opportunity to select their own code name for the research.

All eighteen questions were relevant for, and asked of, the management level group and the lecturing level group. Thirteen questions were asked of the governance policy group as some questions were deemed to be outside the experience of this group of participants and could lead to inaccurate responses. Nine questions were to be asked of the student group.

4.5.8 Review of Questions by the Researcher

Before the commencement of the round one interviews the questions were reviewed one final time and it was concluded that question 8 reflected on a piece of work that the researcher had previously prepared. As such, the question may have inadvertently introduced bias into the interview. Question 8 was then omitted from the list of questions asked of participants. The full seventeen questions for the Delphi round one semi-structured interviews are given in Table 4.6 and appendix I of this thesis.

Question Number	Delphi Round One Interview Question
1	What is your name and your role in your organisation? How many years are you in your current role?
2	Have you experience of the following quality assurance processes? If so, how many times? (i) Programmatic review (ii) Engineers Ireland accreditation

3	Was your experience of the quality assurance processes in engineering education positive or negative? (i) For programmatic review (ii) For Engineers Ireland accreditation
4	To what extent did the programmes improve as a result of these quality assurance processes?
5	Should the programmatic review and Engineers Ireland accreditation processes be combined into one quality assurance process for engineering education programmes and why?
6	To what extent do you think there are any advantages to combining the two processes into one major quality assurance process?
7	To what extent do you think there are any disadvantages to be encountered as a result of combining the two processes?
9	To what extent are there parts of either process that are likely to prevent the combining of both processes?
10	(i) Who do you think are the main stakeholders in the programmatic review process? (ii) Who do you think are the main stakeholders in the Engineers Ireland accreditation process? (iii) Who do you think we may have forgotten to include?
11	To what extent is it likely that the cyclical cycles of the programmatic review and accreditation processes can be synchronised?
12	(i) Should the Engineers Ireland accreditation process be mandatory or voluntary and to what extent? (ii) How could the voluntary nature of the accreditation process be maintained if both systems are combined?
13	How could the agenda be changed for the site visit to allow for the combined programmatic review/accreditation processes?
14	How could the assessment of the Engineers Ireland accreditation criteria by the evidence-based methodology be incorporated into the programmatic review process or vice versa?

15	Overall responsibility for the programmatic review lies with the Institute's academic council, through the Registrar's office. Overall responsibility for the Engineers Ireland process lies with the Engineers Ireland accreditation board, through the Engineers Ireland Registrar's Office. (i) How could the responsibility for these processes be managed in the combined scenario? (ii) To what extent should there be joint responsibility and how do you think this would work?
16	(i) How could communication and liaison be managed between the faculty/department, Institute Registrar's Office and the Engineers Ireland Registrar (ii) How could communication and liaison be managed between the final programmatic review report and the Engineers Ireland accreditation board?
17	The two quality assurance processes have independent outcomes. Should the independence of the outcomes be maintained and why?
18	Is there anything you would like to add or anything that I should have asked?

Table 4.6: Delphi Round One Interview Questions

4.6 Research Participant Identification

4.6.1 Sampling in this Research

According to Brinkmann and Kvale (2015), qualitative interviews seek knowledge expressed in normal language. Interviews can be conducted in order to develop knowledge for, and through, collective activities. A semi-structured interview attempts to understand themes from the experience of the participants. This kind of interview seeks to obtain the meaning of the described experience. Semi-structured interviews are neither an open conversation nor a closed questionnaire and are conducted according to an interview guide that focuses on certain themes and questions (Brinkmann & Kvale, 2015).

The Delphi technique does not use a random sample representative of the target population but samples from experts in the area who have an interest or involvement with the question or issues being addressed (Keeney, et al., 2001).

The selection of the expert panel is regarded as the lynchpin of the method and they are selected on the basis of their knowledge, expertise, experience and willingness to participate (Green, et al., 1999). The number of research participants varies from 10 to 50 in the majority of Delphi studies, but is normally between 20 to 30 participants (Keeney, et al., 2001).

Key informants are individuals, who may be gatekeepers, who have specific knowledge or experience of interest to the researcher (Higginbottom, 2001). Crookes and Davies (1998) defined purposive sampling as the *'judgemental sampling that involves the conscious selection by the researcher of certain participants to include in the study*.'

A grounded theory methodology demands concurrent data collection and analysis, so that more individuals who have the knowledge and experience in the area of the research can be recruited to the study as the research progresses and preliminary findings emerge. This is known as theoretical sampling (Higginbottom, 2001).

In this study, purposive sampling selected stakeholders who have knowledge, expertise and experience of the programmatic review and accreditation processes in engineering education and were willing to contribute to the research. The average number of years that the research participants were performing their current job role was nine years. Participants had experience of managing or participating in at least three cycles, on average, of the programmatic review process and three cycles, on average, of the Engineers Ireland accreditation process in their own HEI.

4.6.2 Initial List of Research Participants

Based on the four levels of questions prepared for the round one interviews, an initial participant list was prepared. The criteria used to generate this list included:

- Participant's knowledge, expertise and experience of the programmatic review and accreditation processes in engineering education;
- Participant's probable willingness to engage in the research, garnered from the researcher's previous interactions with these participants;
- Selection by group level – a balance of governance/policy level participants, management level participants and lecturer level participants;
- Selection by sub-group level – a balance between the participant groups at sub-group level. This included a balance between Heads of Faculty and Heads of Department, Senior Lecturers and Lecturers, Governance Heads and Registrars;

- Selection by engineering discipline. The participant’s expertise and role in managing civil engineering, mechanical engineering and/or electrical engineering;
- Limited to approximately thirty participants to ensure a reasonable quantity of data for analysis. The research literature recommends no fewer than fifteen participants in a multi-level, Delphi technique three rounds study;
- Engagement with the processes on a regular basis. Thus, there were more participants from the management level as it forms a greater proportion of their work activities.

Serious consideration was given to the inclusion of student participants in the research but the conclusion reached was that they would not have the level of knowledge or experience of the quality assurance processes which would allow them to make an informed contribution to the research. This was regrettable but deemed necessary to maintain the integrity of the Delphi process, which rests on expert judgement.

The voice of the professional bodies was missing from the initial list of participants so three professional association representative participants were selected from the well-known professional associations in engineering and construction. These were analysed separately as the professional association representative group. The Governance group were analysed as the Registrar group.

A Greek letter was assigned to each participant as their anonymity code for the research. The initial participant list captured the research level/group, participant’s role, their organisation, participant’s name and the initial anonymity code. This list is shown in Table 4.7.

Thus, initially, eight participants were proposed for the governance/registrar group, three participants for the professional association group, eleven participants for the management group and eight participants for the academic staff group. The literature recommended that 20-30 participants is normal for a three round Delphi Technique study.

No.	Level/ Group	Organisation	Role	Name	Code
1	Governance/Policy		Chairman of Organisation		α
2	Governance/Policy		President of an IoT		β
3	Governance/Policy		Senior QQI representative		γ
4	Governance/Policy		Registrar		δ
5	Governance/Policy		Registrar		ο
6	Governance/Policy		Registrar		ε
7	Governance/Policy		Registrar		ζ
8	Governance/Policy		Registrar		ρ
9	Prof. Association		Registrar		θ
10	Prof. Association		Education Manager		ϯ
11	Prof. Association		Education Manager		Ω
12	Management		Head of Faculty – C, M, E		κ
13	Management		Head of Faculty – C, M, E		λ
14	Management		Head of Faculty – C		μ
15	Management		Head of Faculty– C, M, E		ν
16	Management		Head of Department – M, E		ξ
17	Management		Head of Department - C		η
18	Management		Head of Department – M, E		Δ
19	Management		Head of Department - C		σ
20	Management		Head of Department – M, E		τ
21	Management		Head of Department - C		ϕ
22	Management		Head of Department – M, E		π
23	Academic Staff		Senior Lecturer - C		χ
24	Academic Staff		Senior Lecturer - C		ψ
25	Academic Staff		Lecturer - C		ω
26	Academic Staff		Lecturer - C		ς
27	Academic Staff		Senior Lecturer – M, E		ϐ
28	Academic Staff		Senior Lecturer – M, E		Ͽ
29	Academic Staff		Lecturer – M, E		Ϫ
30	Academic Staff		Lecturer – M, E		ϰ

Table 4.7: Initial Research Participant List

C - civil engineering expertise/responsibilities. M – mechanical engineering expertise/ responsibilities. E - electrical/electronic engineering expertise/responsibilities.

4.6.3 Initial Communication with Research Participants

Initial communication with potential participants commenced in October 2017 and continued to March 2018. In the majority of cases, five instances of communication with potential participants occurred during this timeframe as follows:

- Initial brief telephone/verbal contact to request the participant's contribution to the research and explain the ethical consent process;
- An email communication attaching the research information letter and consent form for completion;
- The return of the completed consent form;
- A brief telephone/email contact to agree the date/time for the interview and whether it is by telephone or face-to-face (participant to select);
- A brief reminder email one/two days prior to the interview.

4.7 Delphi Round One Interviews

4.7.1 Setting up the Round One Interviews

Interviews with elites and policy makers pose added challenges including access and time constraints (Green, et al., 2009). All thirty potential participants confirmed to the researcher that they would be interested in contributing to the research. However, three of the potential participants did not return the consent form as follows:

- One of the governance/policy group – a registrar;
- One of the management group – a mechanical/electrical head of department;
- One of the professional association group – an education manager.

The senior QQI representative was meeting with the researcher and the Registrar of Engineers Ireland at the time, and this person confirmed that QQI would support this research study through this form of engagement. As a result, there were twenty-six participants who contributed to the Delphi round one semi-structured interviews.

Twenty-four participants selected to be interviewed by telephone. Two participants were interviewed in their place of work. A monitoring template was prepared to monitor the communication with potential participants.

Table 4.8 provides the information shown in the monitoring template which includes:

- Name of the participant, email address and contact telephone number;
- Date of the initial contact with potential participants;
- Date when consent letters and consent forms were sent to potential participants;
- Date when the completed consent forms from these participants were received;
- Noting of the date and time when the interview took place.

Participant Code	Contact Date	Date Information Letter & Consent Form Sent	Date Completed Consent Form Received	Date of Interview	Time of Interview
α	06/10/2017	22/10/2017	05/12/2017	16/01/2018	9.30
β	17/11/2017	17/11/2017	17/11/2017	22/01/2018	16.00
δ	06/10/2017	22/10/2017	23/10/2017	23/01/2018	16.00
ε	06/10/2017	22/10/2017	22/10/2017	18/01/2018	11.00
ζ	06/10/2017	22/10/2017	31/10/2017	30/01/2018	14.00
π	24/11/2017	24/11/2017	08/12/2017	31/01/2018	12.00 Visit
ρ	30/11/2017	01/12/2017	04/12/2017	22/01/2018	12.00
θ	27/10/2017	29/10/2017	11/12/2017	15/01/2018	13.30 Visit
ɟ	22/11/2017	22/11/2017	31/11/2017	17/01/2018	15.00
κ	17/11/2017	17/11/2017	17/11/2017	22/01/2018	14.00
λ	27/10/2017	29/10/2017	31/10/2017	16/01/2018	13.00
μ	27/10/2017	29/10/2017	31/10/2017	16/01/3018	11.00
ν	27/11/2017	01/12/2017	05/12/2017	17/01/2018	16.00
ξ	01/11/2017	02/11/2017	06/11/2017	17/01/2018	11.00
η	27/10/2017	29/10/2017	31/10/2017	19/01/2018	12.30
σ	06/10/2017	22/10/2017	06/11/2017	05/02/2018	12.00
τ	27/10/2017	29/10/2017	06/11/2017	22/01/2018	10.00
ϕ	06/10/2017	22/10/2017	23/10/2017	16/01/2018	14.00
χ	17/11/2017	20/11/2017	20/11/2017	16/01/2018	16.00
ψ	20/11/2017	20/11/2017	20/11/2017	17/01/2018	14.00
ω	21/11/2017	22/11/2017	24/11/2017	23/01/2018	16.30
ς	27/10/2017	29/10/2017	01/11/2017	16/01/2018	15.00
ϐ	13/12/2017	13/12/2017	13/12/2017	15/01/2018	11.00
϶	09/02/2018	09/02/2018	09/02/2018	26/02/2018	14.30
Χ	09/02/2018	09/02/2018	21/02/2018	12/03/2018	11.00
ϰ	11/04/2018	11/04/2018	23/04/2018	21/05/2018	10.00

Table 4.8: Communication with Potential Participants for Round One Interviews

Visit – The researcher had a face-to-face interview with the participant.

4.7.2 Conducting the Round One Interviews

The mechanical/electrical engineering staff were more challenging to contact than the other interviewees as these participants had to be found through intermediaries. These interviews were thus delayed with the final round one interview held on 25th May 2018. After some rescheduling to cater for participant's busy roles, the final schedule of round one interviews is given in Table 4.9 in chronological order.

Interview Date	Interview Time	Participant Code	Question Group
15/01/2018	11.00	ϐ	Lecturer
15/01/2018	13.30	θ	Governance/Policy
16/01/2018	9.30	α	Governance/Policy
16/01/2018	11.00	μ	Management
16/01/2018	13.00	ϰ	Management
16/01/2018	14.00	φ	Management
16/01/2018	15.00	ς	Lecturer
16/01/2018	16.00	χ	Lecturer
17/01/2018	11.00	ξ	Management
17/01/2018	14.00	ψ	Lecturer
17/01/2018	15.00	ϯ	Governance/Policy
17/01/2018	16.00	ν	Management
18/01/2018	11.00	ε	Governance/Policy
19/01/2018	12.30	η	Management
22/01/2018	10.00	τ	Management
22/01/2018	12.00	ρ	Governance/Policy
22/01/2018	14.00	κ	Management
22/01/2018	16.00	β	Governance/Policy
23/01/2018	16.00	δ	Governance/Policy
23/01/2018	16.30	ω	Lecturer
30/01/2018	14.00	ζ	Governance/Policy
31/01/2018	12.00	π	Management
05/02/2018	12.00	σ	Management
26/02/2018	14.30	Ͽ	Lecturer
12/03/2018	11.00	Ϫ	Lecturer
25/05/2018	12.00	λ	Lecturer

Table 4.9: Final Round One Interview Schedule

All the participants agreed to have the interview recorded using the digital voice recorder, including the interviews which were conducted face-to-face.

A '*Prelude to Interview Questions'* document was prepared to inform the participants of the context of the proposed research, the research title, the ethical approvals, the ground rules, the interview process, and the document also highlighted the valuable contribution the participants were making to the research, provided an option on whether the interview would be recorded, the selection of the code name by the participant and the research confidentiality. The content of the Prelude to Interview Questions document was read to participants at the beginning of the semi-structured interview and this document is shown in Table 4.10.

Context	Quality assurance in engineering education programmes primarily involves two processes – internal programmatic review and external accreditation.
Research Title	Engineering education quality assurance processes – Exploring if the accreditation process of engineering programmes in Ireland can be brought into closer alignment with the programmatic review process of these programmes.
Proposed Research	If it is possible to bring the two processes into closer alignment, then it could allow for the establishment of a single collaborative quality assurance process or facilitate sequential occurrence in the same time frame.
Interviews	The purpose of the interview is to garner your views on the programmatic review and accreditation processes and to explore if they can be combined into one quality assurance process.
Interview Process	It is intended that this interview should take no more than 30 minutes. Participants with different roles and responsibilities have been invited to be interviewed. Each participant brings a different perspective to the research. Your contribution is valued especially if different to the generally expressed view. All information provided at this interview will not be released to any other third party. All names will be changed and coded. You may choose whether to be taped or not taped.

Table 4.10: Prelude to Interview Questions

Participants were contacted by telephone or the researcher travelled to their work location to conduct the interview. Rapport with the participants was established by greeting them and reiterating the confidentiality of the interviews. The content of the prelude sheet was read to each participant and any queries that they had were answered. The participant stated whether they agreed to the interview being recorded and some selected their own code name. Participants were informed in advance, before the voice recorder was switched on, and when it was turned off. The research questions were asked by the researcher and answered by the participant sequentially as per their level group. Additional questions were posed when the participant provided an unclear or unusual response. When the final question was answered the digital recorder was switched off. The interview ended by thanking the participant for their contribution and alerting them to the next steps in the research.

4.7.3 Transcribing the Round One Interviews

When each interview was ended, the recording from the digital voice recorder was transferred to a password protected computer. A transcription service was engaged to provide documented transcripts of the interviews for analysis of the interview content. Transcription was completed between 11th April and 20th June 2018. The digital transcript files were transferred to the researcher’s password protected computer and deleted from the transcriber’s computer.

4.7.4 Overview of the Analysis of the Round One Interviews

The interviews were re-organised on a question by question basis. Initially, the interviews were analysed on an individual question basis to unearth the common threads running through the interviews. This was followed by an analysis by theme across all the interview questions. The emergence of overarching themes was identified and all participant responses were scrutinised irrespective of whether they formed part of an emergent theme. All the analysis was gathered into narrative summaries per question and theme to ensure all the data was available for consideration. The overarching themes were linked to the research objectives and assisted with the development of the round two questionnaire.

4.8 Delphi Technique Round Two Questionnaire

4.8.1 Generation and Organisation of the Questions for Round Two

When the round one analysis was complete, the outcome was used to assist with the development of the round two questionnaire for distribution to the research participants. The initial phase of the development of the questionnaire was to decide on its structure. The researcher reviewed:

- The research question;
- What outcomes were expected from the research;
- How each interview question from round one was developed;
- Omitted questions that were intended to be included in the questionnaire;
- The overarching themes from round one;
- Likert scales for use in rating opinions in questionnaires.

Likert scales were considered to assist with garnering participant opinions in a questionnaire. As the objective in the Delphi technique is to achieve consensus amongst participants and the constructivist grounded theory is to achieve theoretical saturation, it was decided the use of a Likert scale would achieve these aims. Different forms of a Likert scale were considered and a five-point scale was selected as it would capture the information with sufficient breadth to see variances in opinion whilst not being too long (which could make the analysis unnecessarily confusing). As there was an interview stage as round one, this would not be the first or final time to capture participant comment and aided in trying to achieve consensus. The five-point Likert scale seemed the right size for this study.

The format was kept the same for all the questions so as not to confuse the participants and to keep the completion of the questionnaire as simple as possible for them. It also helped with ensuring that the questionnaire could be completed in the allotted time.

The selected Likert scale was as follows:

- Strongly Disagree;
- Disagree;
- Neither Agree nor Disagree;
- Agree;
- Strongly Agree.

The design of the questionnaire was guided by the overarching themes from round one, which were grouped into two main categories with some overlap between them. The two categories were:

1. Themes principally based on the existing quality assurance processes (programmatic review and accreditation);
2. Themes principally based on future potential review process(es).

Thus, the questionnaire was structured in the same manner as follows:

- Question 1 – Participant's name;
- Question 2 – Quality Assurance Processes – Existing processes;
- Question 3 – Quality Assurance Processes – Revised Process(es);
- Question 4 – Do you have any other comments, questions or concerns?

Questions 2 and 3 had at least eight sub-sections each exploring the various sub-themes that had emerged from the round one interviews. Once the structure of the questionnaire was decided, the overarching themes and the questions deferred from round one was used to create the questionnaire**.** At all times, the research question and the views of the participants from round one was kept in mind.

The questionnaire was then checked for logic and flow of questions and for completeness keeping in mind that the participants were experts and ensuring that they could understand the questions and thus answer them. This involved the revision and moving of questions to other parts of the questionnaire including expanding out questions 2 and 3. At this stage the questionnaire was ready for piloting.

4.8.2 Creating the Online Questionnaire & Piloting the Questionnaire

Survey Monkey was used to create and send the questionnaire. A dedicated Survey Monkey account was purchased to ensure the researcher would be the only person to have access to the data to ensure confidentiality and anonymity of information. The questionnaire was transferred into the *Survey Monkey* platform, which necessitated minor modifications of format and renumbering of questions so that there were 19 questions in total. The survey distribution process via email was tested with three LIT colleagues as recipients; this test also established the time required to complete the questionnaire.

The questionnaire was sent to all twenty-six participants via email with the Survey Monkey link and the questionnaire participation letter attached to the email on 10th April 2019.

4.8.3 The Distributed Questionnaire

Table 4.11 sets out the tabular form of the Delphi round two questionnaire distributed to the research participants and is available in full in Appendix J.

Q No.	Please Rate How You Would Agree or Disagree with each of the Following Statements on the Processes	SD	D	N A/D	A	SA
1	Your name: ____________________					
2	***Quality Assurance Process Overview*** The programmatic review process is a necessary part of an engineering programme development cycle. The Engineers Ireland accreditation process is a necessary part of an engineering programme development cycle. The HEI/Faculty are checking the validity, currency and relevance of their engineering programmes through these processes. The HEI engineering programme(s) should hold up internationally where student qualifications are recognised abroad. The programmatic review and Engineers Ireland accreditation process have different motivations, drivers and stakeholders. The processes ensure reflection on engineering programme content and how it is being delivered. The programmatic review process is strategic direction focused with emphasis on the student experience and HEI profile. The Engineers Ireland accreditation process focuses on maintaining professional standards. The depth of analysis is broader in the programmatic review process whereas the Engineers Ireland accreditation process audits the programme with granular and detailed checking of evidence. The programmatic review panel reviews the self-evaluation statistics. The accreditation panel reviews the evidence behind the statistics.					

3	***Mandatory or Voluntary Engineers Ireland Accreditation Process*** The Engineers Ireland accreditation process should remain voluntary (not imposed). A mandatory Engineers Ireland accreditation process would remove confusion as to which engineering programmes are accredited by Engineers Ireland. Combining the two processes into a single process would make the Engineers Ireland accreditation process mandatory for all engineering programmes.					
4	***Prospective and Retrospective Processes*** The programmatic review process is a prospective process with an emphasis on programme forward planning for the next five years. The Engineers Ireland accreditation process is mainly a retrospective programme assessment process based on evidence from the previous five years. Aligning/combining the two processes could provide a stronger link between past performance and future plans.					
5	***Quality Assurance Review Cycles*** Synchronising of the review cycles can be achieved where the review period for both processes are in phase. There should be one combined comprehensive review including professional accreditation every five years. An interim sub-review may be needed for some technology areas as the five-year review period may be too long. Aligning/combining the quality assurance reviews for engineering education depends on the review period for both processes being five or six years. An aligned/combined process should require less frequent staff and stakeholder buy-in.					
6	***Similarities Between the Two Processes and its Effect on Workload*** There is a lot of cross-over between what is covered in the two processes; e.g. introductory sessions, stakeholder meetings, etc. There is a huge workload for staff to complete these cumbersome processes which take an inordinate amount of time and effort.					

7	***Validation and Accreditation Objectives*** Programmatic review and Engineers Ireland accreditation requirements were created in isolation from each other and do not coincide at present. Similar objectives between the two processes generates considerable overlaps in the execution of the processes. QQI Engineering Award Standards and the Engineers Ireland accreditation criteria need to be aligned. One collaborative aligned or combined process needs to be agreed by QQI, HEIs and Engineers Ireland.					
8	***Engineering Programmes Not Accredited by Engineers Ireland*** Not all programmes go forward for accreditation as the engineering specific Engineers Ireland accreditation process does not reflect the range of programmes in the HEIs Faculties of Engineering. Some engineering/construction programmes are not Engineers Ireland accredited but are accredited by other professional bodies. New programmes wait three/four years to have sufficient evidence and graduates. Non-standard entry to programmes can limit programme accreditation. There are different categories of accreditation recognition. A programme may be validated to one NFQ level but may be accredited to one of three professional levels.					
9	***Panel Membership*** Consistency in panel member competency could be improved with training. The programmatic review panel (in a revised process) would need to be constituted to meet the needs of the two processes as there are two separate outcomes – validation and accreditation. Some panel members would be needed for both processes. Panel members for the evidence review could arrive at a later time in the process.					

10	***Revised Process – Align or Combine?*** A revised (aligned/combined) process will provide greater compatibility between professional and academic engineering education. A process could be agreed between HEIs, QQI and Engineers Ireland, whether combined or aligned, where the HEI is the driving force to incorporate the accreditation requirement. The evidence-based methodology (evidence review) should be included in the revised process. Significant parts of one process can be transferred into the other process where the changes to documentation requirements reflects both processes. It is feasible to run processes simultaneously and keep separate to maintain two independent outcomes – one panel reviews future plans while the other sub-panels are conducting the evidence reviews. The revised processes would reduce the quantity of work the Engineers Ireland accreditation panel has to undertake. The chairpersons of individual Engineers Ireland accreditation panels could sit on the programmatic review panel and present their findings to the Engineers Ireland accreditation board.					
11	***Revised Process – Independence of the Quality Assurance Outcomes (Validation and Accreditation)*** It is appropriate to have two quality assurance outcomes – validation and accreditation. There could be a single process (combined) leading to a single outcome. Programme reviewed academically and professionally. There could be one process but two outcomes. Validation automatically leads to accreditation. There could be two processes outcomes independently from an aligned process where the Engineers Ireland accreditation process is voluntary – Aligning the two processes while maintaining separate outcomes.					

12	***Advantages to Aligning/Combining the two Quality Assurance Processes*** There are no advantages to aligning/combining the two processes. Aligning/combining the processes could reduce the significant body of review activity. Aligning/combining the processes could achieve efficiency in time, effort, documentation and workload. The revised process(es) could examine programmes at the same point in time. The revised process(es) could unlock more time for staff to focus on other initiatives.					
13	***Disadvantages to Aligning/Combining the two Quality Assurance Processes*** There are no disadvantages to aligning/combining the two processes. Ensuring an agreement between QQI and Engineers Ireland on a collaborative process is important as they have different requirements of the processes. Engineers Ireland have statutory entitlement to have their own accreditation process and must demonstrate independence from influence to their international partners. The revised processes may not be suitable for other professional bodies and their partnerships. The possibility of losing the benefits of the Engineers Ireland accreditation evidence approach if it is scaled bask to suit the programmatic review process. Answering to two masters in the one process may require significant panel member guidance.					
14	***Barriers to Aligning/Combining the two Quality Assurance Processes*** There are no barriers to aligning/combining the two processes. Some changes are needed to both processes to accommodate the other process. The evidence-based approach is not currently compatible with the programmatic review process.					

	An agreed protocol is needed at a high level to provide clarity on the documentation and timing of the evidence review. Interviews with employers/graduates is programme specific in the Engineers Ireland accreditation process. Some engineering programmes accredit to more than one professional body. Mapping of engineering programmes to many sets of standards.					
15	***Method of Alignment/Combination of the two Quality Assurance Processes*** Aligned – Engineers Ireland accreditation process is embedded in the programmatic review process. Aligned – Programmatic review process is embedded in the Engineers Ireland accreditation process. Combined – Integrate both processes into a single process. Programme going for Engineers Ireland accreditation, incorporate the essential unique parts of the accreditation process into the programmatic review process. Create a time slot in the programmatic review process for the evidence review and interviews with stakeholders. Multiple professional bodies could attend in the Engineers Ireland accreditation slot of the programmatic review process.					
16	***Revised Process – Agenda*** The agenda for the programmatic review is set by the HEI academic council. The agenda for the Engineers Ireland accreditation process is set by the Engineers Ireland accreditation board. Sequence the site visit agenda(s) to suit the objectives of the programmatic review and Engineers Ireland accreditation processes. The aligned process follows a natural progression of critical self-evaluation, mapping to QQI Engineering Standards and the Engineers Ireland accreditation criteria, evidence gathering and site visit. Additional time may be required to include all the requirements for the programmatic review and Engineers Ireland accreditation processes.					

17	***Responsibilities of Stakeholders in the Revised Process*** Responsibility for the programmatic review process is through the HEI academic council. The academic council signs off on the programmatic review process and approves programmes on their programme register. Responsibility for the Engineers Ireland accreditation process is through the Engineers Ireland accreditation board. Engineers Ireland approves accredited programmes on their register. There should be shared responsibility between the HEI Registrar and the Engineers Ireland Registrar as neither party can cede responsibility to the other party. Agree the revised process between HEIs, QQI and Engineers Ireland. Clear protocols for responsibility and approval to be stated. Embed in the HEI quality assurance framework. The revised process needs a Joint Overseeing Group for decisions.					
18	***Revised Process – Communications Management*** Liaison between organisations needs to be managed by the Faculty Head in consultation with the HEI Registrar, Engineers Ireland Registrar and relevant Heads of Department. All communication, including liaison and report generation, sign-off and sharing needs to be agreed between HEIs, QQI and Engineers Ireland. Clear protocols and confidential issues need to be clarified. For the combined scenario, one single report could be produced with section one the common issues, section two the programmatic review process outcomes and section three the accreditation reports. For the aligned scenario, two separate reports, within the same timeframe, could be agreed. The accreditation report to be added to the programmatic review report (possibly in an annex). The programmatic review reports are published and widely available. The accreditation reports to be published in the revised process(es).					
19	Do you have any other comments, questions or concerns?					

Table 4.11: Delphi Round Two Questionnaire

SD = Strongly Disagree D = Disagree N A/D = Neither Agree nor Disagree A = Agree SA = Strongly Agree

4.8.4 Questionnaire Responses

A *Questionnaire Communication with Participants* monitoring document was created that allowed responses to be tracked (Table 4.12).

Participant Code	Date Questionnaire Received	Date Reminder Email Sent	Date of Follow up Phone call	Survey Monkey Response No.
α	12/04/2019	n/a	n/a	6
β	12/04/2019	n/a	n/a	7
δ	11/04/2019	n/a	n/a	4
ε	13/05/2019	10/05/2019	n/a	21
ζ	13/04/2019	n/a	n/a	10
ρ	16/04/2019	n/a	n/a	12
θ	23/05/2019	10/05/2019	22/05/2019	24
ʇ	20/05/2019	10/05/2019	n/a	22
κ	10/05/2019	10/05/2019	n/a	19
λ	16/04/20119	n/a	n/a	11
μ	17/04/2019	n/a	n/a	13
ν	10/05/2019	10/05/2019	n/a	17
ξ	10/04/2019	n/a	n/a	2
π	08/05/2019	n/a	n/a	16
η	18/04/2019	n/a	n/a	14
σ	12/04/2019	n/a	n/a	5
τ	10/05/2019	10/05/2019	n/a	18
ф	12/04/2019	n/a	n/a	8
χ	10/04/2019	n/a	n/a	1
ψ	n/a	10/05/2019	22/05/2019	n/a
ω	25/04/2019	n/a	n/a	15
ς	20/05/2019	10/05/2019	n/a	23
ϐ	10/04/2019	n/a	n/a	3
Э	12/04/2019	n/a	n/a	9
Ҳ	13/05/2019	10/05/2019	n/a	20
ϰ	n/a	10/05/2019	22/05/2019	n/a

Table 4.12: Questionnaire Communication with Participants *n/a is not applicable*

Twenty-four participants responded to the questionnaire from 10th April to 23rd May 2019 with the majority of these collected by Survey Monkey in the first three weeks. On 10th May a reminder email was sent to the ten remaining participants who had not responded to the survey by that date. On the 23rd May the researcher placed a telephone call to the remaining three participants. The researcher had a conversation with one participant and was unable to contact the other two participants. One further questionnaire response followed this communication which was the twenty-fourth and final response to the questionnaire.

There were twenty-six participants in round one and twenty-four of them responded to the questionnaire which was a response rate of 93%.

4.8.5 Overview of the Analysis of the Questionnaires

The approach taken to the analysis of the questionnaire followed a similar pattern to the analysis of the Delphi round one interviews. The questionnaires were initially analysed by individual question and then by theme including the analysis by group type and engineering discipline. The analysed data was gathered into narrative summaries by question and theme. Identification of the themes that had achieved consensus ensued. Outputs of the analysis of the questionnaires are discussed in chapter six and given in the appendices.

4.9 Delphi Technique Round Three Interviews

4.9.1 Generation of Round Three Interview Questions

Having completed the analysis of the round two questionnaire (described in detail in chapter six), the researcher created the overarching round two outcomes for the research. The purpose of these overarching outcomes is to provide controlled feedback to the research participants as part of the adapted Delphi technique methodology that was used for this study.

Returning to the seventeen themes and eighty-three sub-questions/sub-themes generated as the outcomes from the round one analysis these were examined to ascertain the level of agreement amongst the responses from the research participants to the questions posed in the questionnaire. All neutral and negative responses were also recorded for each theme and sub-theme to allow for further analysis.

It emerged from this examination that the responses to the questionnaire fell into two categories; those sub-themes that gained general agreement (more than 80% of the respondents agreed with the sub-theme) or the unresolved issues that generated a wide range of responses from the participants.

Responses under each of the themes and their sub-questions/sub-themes were allocated to the two categories and the information displayed on a two dimensional excel table. This table allowed the researcher and participants to see clearly where there was general agreement and where there were some issues still to be resolved which could be included in the round three interview questions.

The round two research outcomes were issued to participants with their invitation to participate in round three of the research to complete the Delphi feedback loop. A sample of the round two outcomes table is given in Table 4.13 and the full document is given in Appendix K of this thesis.

Theme	General Agreement	Unresolved Issues
Revised Process – Align or Combine	Revised Process – Greater compatibility between professional and academic engineering education	
	A process should be agreed between HEI’s, QQI and Engineers Ireland	
	The evidence review should be included in the revised process	
	Significant parts of one process can be transferred into the other process	
		Run processes simultaneously and keep them separate
	Revised process – reduces workload for Engineers Ireland panel	
	Chairs of Engineers Ireland accreditation panels could sit on the programmatic review panel	

Table 4.13: Sample of the Round Two Overarching Outcomes

The overall outcomes for the 1992 responses to the sub-questions in the questionnaire was as follows:

- *75%* expressed agreement with the themes/sub-themes;
- *11%* expressed disagreement with the themes/sub-themes;
- *14%* were unsure and selected the neither agree nor disagree option.

From the unresolved themes highlighted in the round two outcomes were generated a series of questions that would allow for these sub-themes to be further explored in round three. This required a review of each of the seventeen themes and sub-themes and the consideration/generation of appropriate questions to capture the information from the research participants. From this analysis an initial draft of round three questions was generated.

There was a danger that returning to these same themes would only generate the same variety of responses as seen in the round two questionnaires so they needed to be explored in a different context. The approach to doing this emerged from a presentation I made at the Engineers Ireland Engineering Education Conference on 30th October 2019 and from discussions with conference delegates. As a result, I came to the conclusion that it would be useful to hang the questions on a revised quality assurance process model**.** There was divided opinion on whether the programmatic review should form part of the Engineers Ireland accreditation process or vice versa. Most delegates preferred the programmatic review processes being absorbed into the Engineers Ireland process which is the opposite of the CoHSE viewpoint but not surprising as this was the Engineers Ireland conference.

This meant that the questions were framed as part of the most likely combination of the two major quality assurance processes, namely the programmatic review process is modified to combine with the Engineers Ireland accreditation process. In reality, both processes would have to change to accommodate this procedure but it allowed the questions to be set in a new context.

The Round three questions are set out in Table 4.14.

Question Number	Round Three - Questions
1	What is your name?
2	The Engineers Ireland accreditation process is voluntary at present. In a revised process, should it remain voluntary?
3	Should a review cycle of five or six years be specified for the revised process?
4	Based on the research outcomes to date and discussions with stakeholders and gatekeepers, I am putting forward a revised quality assurance model where the programmatic review process is adapted to combine with the Engineers Ireland accreditation process.
4a	Is it practical to include the programmatic review unique parts into the Engineers Ireland accreditation process and how can it be achieved?
4b	Should the entire evidence review be part of this revised process?
4c	Is it practical to have two independent process outcomes (validation and accreditation) from this combined process?
4d	Should one collaborative report or two separate reports for the processes be produced?
4e	Is it appropriate that the duration of the site visit be extended to include all the parts of both processes?
4f	Is it practical to have one set of documentation that captures the relevant information needed for the combined processes?
4g	Should this combined process be the template for interactions with other professional associations and why?
5	There are many other ways to align/combined the two processes. Would another method of alignment/combination be more appropriate and why?
6	Should non-standard entry to programmes affect their ability to be accredited by Engineers Ireland?
7	Any other questions, concerns or comments?

4.14: Round Three Interview Questions

4.9.2 Communication with Research Participants

The researcher prepared a *Round Three Participant Information Letter* which contained almost the same information as the round one participant information letter except for what was expected of the participant in this round. It also included information on the round two outputs.

The entire participant information letter is provided in Appendix E of this thesis. This letter was sent to the twenty-four round two participants, by email, where the research participant letter for round three could be attached to the email as well as the round two outputs. The potential participants were informed, in separate individual emails, that the researcher would be in contact by telephone to arrange the interview if the participant was willing to contribute to this stage of the research. All the emails were sent to the potential participants on 23rd November 2019.

4.9.3 Setting up the Interviews

A Round Three Communication Monitoring Document, in the form of an excel two-dimensional table, was created to manage and monitor the communication with the potential participants. For each potential research participant for round three this monitoring document logged the contact date by telephone to arrange the interview and the date and time of the interview. The Round Three Communication Monitoring Document is shown in Table 4.15.

One of the research participants from round two was unable to be contacted, so twenty-three interviews were held for round three of the research (95% response rate). Twenty-six participants contributed to round one and twenty-three of them contributed to round three which gives an overall research participant response rate of over 88%.

The Round Three *Interviews Schedule* in chronological order is shown in Table 4.16.

Participant Code	Contact Date by Telephone to Arrange the Interview	Date of Interview	Time of Interview
α	27/11/2019	10/12/2019	16.30
β	27/11/2019	13/12/2019	9.00
δ	27/11/2019	09/01/2020	16.00
ε	27/11/2019	13/12/2019	12.00
ζ	26/11/2019	Email Response	n/a
ρ	27/11/2019	10/12/2019	8.30
θ	27/11/2019	10/12/2019	16.00
ɟ	27/11/2019	09/01/2020	15.00
κ	27/11/2019	11/12/2019	17.00
λ	25/11/2019	02/12/2019	14.00
μ	27/11/2019	09/01/2020	16.30
ν	25/11/2019	03/12/2019	16.30
ξ	25/11/2019	03/12/2019	15.30
π	27/11/2019	11/12/2019	9.00
η	28/11/2019	03/12/2019	13.00
σ	29/11/2019	13/12/2019	11.00
τ	25/11/2019	Email Response	n/a
φ	27/11/2019	02/12/2019	16.00
χ	27/11/2019	11/12/2019	16.00
ω	26/11/2019	09/01/2020	14.00
ς	27/11/2019	12/12/2019	15.00
ϐ	Unable to contact	n/a	n/a
Ͽ	27/11/2019	12/12/2019	14.00
Ϫ	29/11/2019	02/12/2019	15.00

Table 4.15: Round Three Communication Monitoring Document

n/a is not applicable. ζ and τ sent email responses after requesting the interview questions from the researcher.

Participant Code	Date	Time
λ	02/12/2019	14.00
Ϫ	02/12/2019	15.00
φ	02/12/2019	16.00
η	03/12/2019	13.00
ξ	03/12/2019	15.30
ν	03/12/2019	16.30
ρ	10/12/2019	8.30
θ	10/12/2019	16.00
α	10/12/2019	16.30
π	11/12/2019	9.00
χ	11/12/2019	16.00
κ	11/12/2019	17.00
Ͽ	12/12/2019	14.00
ς	12/12/2019	15.00
β	13/12/2019	9.00
σ	13/12/2019	11.00
ε	13/12/2019	12.00
ω	09/01/2020	14.00
ϯ	09/01/2020	15.00
δ	09/01/2020	16.00
μ	09/01/2020	16.30

Table 4.16: Round Three Interview Schedule in Chronological Order

Two of the research participants decided to respond to the round three questions by email on 27th and 28th November respectively. Therefore, twenty-one round three interviews were conducted between 2nd December 2019 and 9th January 2020.

4.9.4 Conducting the Interviews

A *'Round Three Prelude to Interview Questions'* document was prepared to inform the participants of the purpose of the proposed research, the interview process, provided an option on whether the interview would be recorded and the research confidentiality.

The content of the Round Three Prelude to Interview Questions document was read to participants at the beginning of the semi-structured interview. The document is identical to the document for round one interviews (Table 4.10) except that the interview time was intended to take about eight minutes as the average time for the questionnaire to be completed turned out to be twenty-two minutes.

The researcher contacted the participant by telephone at the agreed date and time and read the content of the Round Three Prelude to Interview Questions document to each participant. All the participants agreed to have the interview recorded using the digital voice recorder and the participant was informed when it was switched on and off. The round three research questions were asked by the researcher, and answered by the participant, sequentially. When the final question was answered the digital recorder was switched off and the participant was thanked for their contribution to the research.

The recording from the digital voice recorder was transferred to the researcher’s password protected computer for further analysis at the end of each interview. In addition, the researcher noted the answers given by each participant on a prepared form so that the analysis could proceed quickly once all the interviews were completed.

4.10 Research Validity and Reliability

Roberts (2006) states that reliability and validity are ways of demonstrating and communicating the rigour of research processes and the trustworthiness of the research findings. Reliability measures the likelihood that similar research outputs will emerge if different participants were interviewed who have similar lived experience. This research plan has to consider and build into the research design credibility, trustworthiness, transferability, dependability and confirmability.

Some limitations to interpretivist research, using grounded theory and the Delphi technique were previously described in Chapter 3 as follows:

- The data may be heavily impacted by personal viewpoints and values;
- There may be bias from the researcher due to the subjective nature of the research;
- The data has a high level of validity but a low level of reliability;
- Transferability of research outcomes is likely to be limited;
- Determining the theoretical saturation of data timescale is difficult.

Some suggested solutions identified in Chapter 3 included:

- Triangulation in researching the social world is recommended by some researchers to improve validity, reliability and generalisability;
- Combining participant observation with interviews and documentary sources;
- Member checking with key informants;
- The findings in one study can be tested or confirmed in another study with a different sample as a means of validation.

4.10.1 Credibility (Validity)

A qualitative study is credible if it reveals accurate descriptions of individuals' experiences and '*that the people having that experience would immediately recognise it from those descriptions or interpretations as their own'* (Sandelowski, 1986). Appleton (1995) argues that credibility can be achieved by taking the data and the interpretations to the research participants to check if they agree with them.

Creswell & Miller (2000) define member checking as '*taking data and interpretations back to the participants in the study so that they can confirm the credibility of the information'*. Member checking is also known as informant feedback and involves systematically obtaining feedback about the researcher's data, interpretations and conclusions from the research participants (Onwuegbuzie & Leech, 2007). Member checking can be described as the practice of researchers sharing interpretations and theorising with the research participants, who can check, amend and provide feedback as to whether they are recognisable accounts consistent with their experience (Bryman, 2001).

A potential difficulty in achieving validity in qualitative research is researcher bias. Roberts (2006) proposes that the credibility of findings is increased if researchers make explicit their presuppositions and acknowledge their subjective judgements. In the case of interviews, the validity of the interview data needs to be considered. A researcher's familiarity with the research setting, its people and processes, is both advantageous and potentially problematic. Such insights can be useful in authenticating responses and findings, but familiarity may also obscure any ambiguous issues that others, from outside the field, might question. The researcher should attempt to suspend their experience, judgement and beliefs (Roberts, 2006).

Triangulation is a validity procedure where researchers search for convergence among multiple and difference sources of information to form themes or categories in a study (Creswell & Miller, 2000). This is consistent with the theoretical framework for this research. Triangulation involves the use of multiple and different methods, investigations, sources and theories to obtain corroborating evidence. It reduces the possibility of chance associations, as well as of systematic biases prevailing due to a specific method being utilised (Onwuegbuzie & Leech, 2007). Triangulation permits researchers to be more certain of their findings, enhances the development on enterprising ways of collecting data and can unravel contradictions (Jick, 1979).

Credibility of research can be established by turning to individuals external to the research where the researcher provides clear documentation of all research decisions and activities (Creswell & Miller, 2000). It can be difficult for researchers to gain complete objectivity in the research so it is helpful if the readers of the research can trace the decision processes throughout the study (Roberts, 2006). Roberts (2006) claims that an audit trail should be evident in the study to demonstrate rigour. This is commonly achieved through the maintenance of a research diary or journal.

Maintaining a research journal involves keeping a log of all activities, developing a data collection chronology and recording data analysis procedures (Creswell & Miller, 2000). The recording of emergent ideas, reflections on personal and on-going examination of personal attitude could prove invaluable at the interpretation stage of the research (Kelliher, 2005).

Thangaratinam & Redman (2005) have identified features of a Delphi technique research design that determine its credibility as a clear decision trail that explains the appropriateness of the method selected, the choice of the expert panel and the data collection procedures. Credibility in this research was achieved by using the following measures principally during the data collection and analysis phases of the research:

- Member checking with the research participants through the controlled feedback at the end of rounds one and two of the Delphi technique and discussion of the research findings with the Registrar of Engineers Ireland;
- Keeping an audit trail. Detailed notes were kept of decisions made throughout the process by maintaining a research journal;
- Triangulation of data during the three rounds of the Delphi process and cross checking with policy documentary evidence and published literature;

- Comparing the findings of this research to the findings of an Engineers Ireland survey on a review of the accreditation process with a different and much larger participant group.

4.10.2 Trustworthiness (Reliability)

In qualitative research, reliability can be thought of as the trustworthiness of the procedures and data generated (Stiles, 1993). Bryman (2001) defines trustworthiness as '*concerned with the extent to which the research outputs are repeatable in different circumstances.*' Reliability refers to the consistency in research outcomes and is defined by Polit and Hungler (1991) as '*the degree of consistency or dependability with which an instrument measures the attribute it is designed to measure.*' This refers to the consistency, repeatability or stability of a study in terms of the final research report.

Keeping an audit trail and a reflective research journal assists with ensuring trustworthiness of the research (Roberts, 2006). Other methods of ensuring reliability include ensuring technical accuracy in recording and transcribing and intensive engagement with the data. Triangulation of data to support the research findings also improves reliability (Kelliher, 2005). For studies using interviews, reliability is dependent on the competency and ability of the researcher's interviewing skills and on the researcher bias (Appleton, 1995).

Measures to ensure that this research is trustworthy include:

- Ensuring technical accuracy in recording and transcribing the data. Electronic devices were used to capture the information;
- Intensive engagement with the interview data. This required many iterations of moving from the data to the interpretations and back again;
- Keeping an audit trail. Detailed notes were kept of decisions made throughout the process by maintaining a research journal;
- Triangulation of data during the three rounds of the Delphi process and cross checking with policy documentary evidence and published literature;
- Comparing the findings of this research to the findings of an Engineers Ireland survey on a review of the accreditation process with a different and much larger participant group size.

4.10.3 Transferability

Similar research outputs can be difficult to achieve in qualitative studies as they are set in the historical contexts pertaining at the time of data collection. Representative sampling of activities within the experience of the participants ensures transferability of the research. Comparing the findings to other similar research will assist with transferability.

Measures to improve transferability in this research include:

- Member checking with the research participants through the controlled feedback at the end of each round of the Delphi technique;
- Triangulation of data during the three rounds of the Delphi process and cross checking with policy documentary evidence and published literature;
- Sampling using experts with experience of both the programmatic review and Engineers Ireland accreditation process and stratifying the sample by using multi-level organisational participants and professional association representatives;
- Comparing the findings of this research to the findings of an Engineers Ireland survey on a review of the accreditation process with a different and much larger participant group size.

4.10.4 Dependability

The stability of the data over time will be enhanced by using all the measures outlined in Section 4.10.1, Section 4.10.2 and Section 4.10.3. The interview data from the expert participants is reflected in the research findings.

4.10.5 Confirmability

The researcher contemplated how the interpretation of the research findings was shaped by the researcher's experience and background. The provision of verbatim interview transcripts and questionnaire responses supported the linking of data to the research findings. Quotes from participants are used when analysing and interpreting the data.

4.11 Conclusion

This chapter utilises the theoretical framework for the research, set out in chapter three, to assist in the design of the research study. An adapted Delphi technique of three rounds for this multi-level study formed the core of the research design. Considerations of validity and reliability featured strongly in the implementation of the research design. Two separate ethical approval processes were followed and approvals were received from the University of Limerick and the Limerick Institute of Technology to conduct the research.

Significant consultation with stakeholders of the engineering education quality assurance processes led to the development of a CoHSE position paper, comparative analysis and concerns and challenges documents. All of the consultations and resulting documentation were subsequently utilised in the generation of the initial questions for this study.

Focus group meetings and a meeting with the research supervisors provided further input to the generation of the Delphi round one interview questions. Purposive sampling of expert research participants led to the identification of the research participants. The interview process for round one included the scheduling of the interviews, communication with the research participants and transcription of the interviews when completed.

The Delphi round two questions were generated from the analysis of the round one interviews. Further communication with participants and the generation of an online questionnaire led to a high retention rate of the research participants for this round of the research. Questionnaire responses were collected by the 'Survey Monkey' platform and analysed to provide the input to the round three interviews. The round three interviews were scheduled and conducted following communication with participants and the feedback of the round two outputs. Details of each step for all three rounds are provided in this chapter.

There was over 75% agreement of the research themes at the end of the questionnaire phase of the research, and this increased by the end of round three leading to consensus of the research findings in all but three themes. Thus, three rounds provided sufficient evidence of consensus and a further round of questions would generate little additional information on the research topic or improve the consensus agreement achieved.

Chapter five will provide the research findings from the Delphi round one interviews. Chapters six and seven will provide the research findings from the questionnaire and Delphi round three interviews respectively.

Chapter 5: Delphi Technique Round One Interview Analysis

5.1 Overview

Chapters five, six and seven provide the research findings for this study. The research findings are divided between three chapters to mirror the data collection phases of the Delphi technique. Each of the Delphi technique round findings needed to be analysed fully before the data collection for the next round could begin, as the analysis formed the basis for the questions asked in the subsequent rounds. Therefore, the data from each round were discrete entities for analysis even though they formed part of the same study, and were iterations of the same data.

The data from all three rounds were analysed in a different way, according to the nature of the data collection method, but followed an overall analysis by question and then theme. Further breakdown by group type and engineering discipline followed where that data was available. The group type and engineering discipline data analysis is only an indicator of trend as the number of research participants in each category was small.

The content of this Delphi technique round one interview analysis is organised into four streams and follows the interview analysis by question, the interview analysis by theme, the emergence of overarching themes involving the linking of the themes with the source of the data as well as an examination of any interview responses which did not form part of an emergent theme and concludes with a summary of the emergent research themes from round one. Analysis within a stream involved a number of stages, in most instances.

The process involved in the analysis by question is described in stream two together with samples of the analysis. Stream three follows the same approach for the analysis by theme and outlines each phase of the analysis in detail. The approach to the generation of the emergent themes is set out in stream four together with a sample of this analysis. Stream four also discusses the emergent themes and links them to the research participants. The depth of support for each theme is appraised together with the frequency of occurrence of the theme. Responses outside of the emergent themes are also considered in this stream. The chapter concludes with a summary of the overarching themes from the Delphi technique round one analysis and their link to the research objectives. These overarching themes were used to assist with the development of the round two questionnaire.

5.2 Round One Analysis by Question

5.2.1 Creation of a Summary Response by the Participant

The round one interview data was transcribed on an individual participant basis. Transcriptions of the recorded interview were made for each participant giving a detailed record of all that transpired during the interview. The data were then reorganised on a question by question basis to prepare the information for analysis.

The participant's responses to each question were carefully read and the transcribed data divided into eighteen separate questions. The transcript was then rearranged into a question by question response from each participant. This activity was time consuming but important because it developed familiarity with the response to every question by each participant. It allowed me to get an overview of the general trend in the responses to the questions. The initial direction of how the combination or alignment of the processes could be achieved began to emerge. At this stage there was a strong indication that an aligned process may be the better way to bring the programmatic review and accreditation processes into closer alignment. An aligned process involves the programmatic review and accreditation processes following each other sequentially within the same timeframe. The preference at this time was for the Engineers Ireland process to be added to the end of the programmatic review process but there were barriers and concerns raised as to whether this outcome was achievable.

The analysis by individual question then commenced and had three main stages which occurred sequentially as follows:

- Creation of a list of comments and comparison across participants' responses;
- Analysis by individual question;
- Creation of a list of emergent themes and comparison across participants' responses.

Table 5.1 gives a sample of the responses from participants to question twelve (should the Engineers Ireland accreditation process be mandatory or voluntary, and to what extent?). This question was selected as an example as it was one of the questions that elicited many views from participants. This question will be used as the example in chapters five, six and seven so that the reader can follow the analysis through the various stages. The participant responses for a selection of the round one questions is given in Appendix L of this thesis.

Participant Code	Mandatory or Voluntary Engineers Ireland Accreditation Process
α	The Engineers Ireland accreditation process is voluntary. To move from a voluntary stance, one would have to make a very strong argument for moving it to a mandatory situation. It comes back to the questions of authority and responsibility. Some of this comes down to who is responsible for what and where ultimately legally this responsibility lies. This would suggest that while Engineers Ireland and other domains will very much want to voluntarily opt in and for the benefit of the students and broader recognition, this process will stay as a voluntary exercise. If both systems are combined, I do not see a difficulty as the voluntary nature would not be compromised by linking the two systems. In some awards, a piece of learning attracts professional exemption or recognition automatically.
λ	I do not think you can make it mandatory so it always has to be voluntary. HEIs to decide individually whether it wants to include it or not in a voluntary way.
μ	For HEIs, Engineers Ireland accreditation should not be mandatory. The default position for HEIs is to seek accreditation for appropriate programmes at the appropriate level. Some HEIs do not seek accreditation because the level of accreditation is not appropriate to the level of award that is offered. Some engineering programmes in Ireland are accredited through UK bodies. I am unsure how it would work in terms of an integrated process unless individual programmes had a choice to opt out. There are different levels of programmes in HEIs and the accreditation process is different for all of them. Some engineering programmes seek professional accreditation from professional associations other than Engineers Ireland.
ξ	Voluntary. Not all programmes will be accredited. If it were mandatory, then there would be a clear marker between the programmes that are accredited and those that are not accredited. HEIs would have to keep the existing programmatic review process for those programmes that do not wish to be accredited.
σ	Yes, it should remain voluntary.

Table 5.1: A Selection of Participant Responses to the Mandatory/Voluntary Accreditation Question

5.2.2 Creation of a List of Comments and Comparison Across Participant's Responses

Once the participant responses by question had been prepared, responses were compared across the twenty-six participants. In addition to answering the question asked, the participants provided insights as to why they gave their answer and how they envisioned the final outcome of the study. There was repetition for many of the participants' responses or similar responses were provided by participants. In order to capture the quantity of agreement between participant responses, a two-dimensional table was prepared, showing the participant views and which participant provided which view. Similar views were gathered under the same section of the table. Table 5.2 illustrates how this analysis was prepared for question twelve. The outcome of this exercise was to identify which categories of information would likely lead to emerging themes for this study.

Participant Code(s)	Mandatory or Voluntary Engineers Ireland Accreditation Process
α, τ	To move from voluntary to mandatory comes back to the questions of authority and responsibility. Who is responsible for what and where legally this responsibility lies? Who will be the boss-QQI or Engineers Ireland?
α,β,ε,ζ,ϰ,ξ,σ, τ,ф,ψ,ς,ϐ,Ꭓ	The Engineers Ireland accreditation process should stay as a voluntary exercise. It should not be imposed.
α,ξ,ɟ,ρ,ф,ψ, ς,β,Ꭓ	The voluntary nature would not be in any way compromised by linking the two processes. If a programme is not going for accreditation, they do their programmatic review in the normal way, and if it is going for accreditation, then include the essential elements of the accreditation process into the programmatic review process.
α	In some awards, a piece of learning attracts professional exemption or recognition automatically.
β,Ꭓ,κ,Э	Where the two processes are fully integrated, the Engineers Ireland accreditation process becomes mandatory. Where the two processes are aligned, the Engineers Ireland accreditation process is voluntary.
β,ε,ρ,δ,ν,ψ	How relevant is the professional association accreditation for graduates to find employment? Civil engineering expects charter membership for sign off but this is not as important for mechanical, electrical or computing engineering. Not all disciplines of engineering need accreditation.

π,ξ,δ,θ,ν,η, Χ,ω,϶	The accreditation process should be mandatory. It adds strength to a programme. It would remove the dilemma of whether a programme is accredited or unaccredited and remove confusion for students and parents.
κ,ϰ,ε,ρ,μ,ϕ, ψ	Where HEIs, and their management, feel they would benefit by having Engineers Ireland accreditation, they should have the option of applying for it at the appropriate level. If HEIs feel that accreditation has value, then Engineers Ireland should be willing to engage with them and come on board to have one process.
ε,ϕ	The freedom should exist for some programmes to be put forward for accreditation and other programmes are not selected for accreditation.
π,ρ	International mutual recognition agreements where qualifications are recognised in other countries makes accreditation more important.
θ	The five-year Olympic event does put strain on HEIs to provide a lot of documentation. Submitting a couple of pages each year should be sufficient if there are any changes to the accredited programme.
θ	To tell a School of Engineering what they are doing wrong, or there is a serious issue, represents failure in their thinking.
ϳ	Some programmes decide not to go forward for accreditation because they may not meet the SCSI threshold standards or they are new programmes.
ϳ	It is a voluntary process, but to maintain accreditation there are compulsory elements that need to be followed.
ϳ	The SCSI process may need to change in the combined process scenario.
τ,Ϫ,μ	Some programmes may not go forward for accreditation as the level of accreditation achieved is not appropriate for the level of award.
Ϫ,μ	Some engineering programmes in Ireland are accredited through UK accrediting associations.
μ	More clarity is required of Engineers Ireland on what accreditation the multiplicity of programmes in Schools of Engineering can achieve.
ν	Technological University mergers raise issues of accredited and unaccredited programmes such as CAO points and honours maths entry.
π	Not everybody appreciates Engineers Ireland accreditation. There can be considerable resistance with the HEI.

π	The current accreditation process is relatively new. International agreements set the standards and procedures used.
ς,η,χ	All engineering programmes in Ireland to be benchmarked to some level of professional skills with the mapping and status identified.
ф,β	New programmes cannot get accreditation until you have graduates from the programme.
Ϫ,χ	We need to separate professional accreditation from general education. All engineers should complete an accredited programme and become chartered.
β	Any programme outside the normal may not be suitable to go forward for Engineers Ireland accreditation.

Table 5.2: Collating of Participant's Views on Mandatory or Voluntary Accreditation

5.2.3 Research Findings of the Round One Analysis by Individual Question

Following the creation of the participant views document, each question was further analysed in turn to determine the number of respondents who agreed, disagreed or had outlier perspectives on the questions asked at interview. This further analysis involved a review of all responses and coding the responses into various categories depending on the question asked. The frequency of participant responses for the various categories was determined in percentage terms. The frequency was determined by dividing the number of participant responses by the number of participants and multiplying by one hundred to get a percentage figure.

To assist with the conversion of these categories into themes, the category information was captured into a question summary two-dimensional table for each question. The question summary table made it possible to see at a glance the responses for each question and the categories that had emerged from the analysis. Even the straight forward questions at the beginning of the interview was treated in the same fashion. The remainder of this section of the chapter will outline the information provided in these question summaries. The question summaries are provided for a selection of questions in Appendix M of this thesis. Table 5.3 and Table 5.4 gives examples of the question summary tables for questions one and twelve. Table 5.4 is provided close to the discussion on the findings of question twelve, later in this section of the chapter.

Participant Group	Participant Discipline	Question Level	Number of Participants	Average Years in Role
Registrar/ Governance	All	G	6	4
Prof. Association	All	G	2	9
Dean, Head of School/Faculty	All	M	4	9
Head of Dept.	Civil	M	3	10
Head of Dept.	Mech/Elec	M	3	5
Senior Lect.	Civil	L	2	17
Senior Lect.	Mech/Elec	L	2	12
Lecturer	Civil	L	2	15
Lecturer	Mech/Elec	L	2	14

Table 5.3: Round One Question One Summary Table

The information provided in Table 5.3 includes the participant role, discipline area of the participant or disciplines that they manage, the level of research questions asked, the number of participants in each level of the HEI or professional association interviewed and the average number of years that the participants had in the role at the time of the interview.

The question two summary table provides details of participants' experience of the programmatic review and the Engineers Ireland accreditation processes. The number of programmatic reviews and Engineers Ireland accreditation events that the participant experienced in their own HEI and other HEIs are shown. The average number of programmatic review and Engineers Ireland accreditation cycles experienced by participants was 3 to 4 for the majority of participants.

The question three summary table provided details of the participant's views of the programmatic review and Engineers Ireland accreditation processes. Four participants did not give an opinion on this question (three registrars and one professional association representative). The researcher categorised the responses into positive, mixed or negative for both the programmatic review and accreditation processes. Eighteen participants (82%) considered the programmatic review a positive experience with three participants (13.5%) having mixed perspectives and one participant (4.5%) expressing a negative response. Eighteen participants (82%) considered the Engineers Ireland accreditation process to be a positive experience with four participants (18%) expressing a mixed experience and none of the participants stating a negative view.

Question four asked the participants to express a view on the extent of programme improvement as a result of the quality assurance processes. The responses were categorised into four categories of marginal improvement, general/overall improvement, extensive improvement and negative improvement. One participant (4.5%) stated there was marginal improvement, eight participants (36.5%) replied that there was overall improvement, thirteen participants (59%) declared extensive improvement and there were no negative responses. Four participants did not express an opinion on this question.

Question five was the first searching question on combining or aligning the quality assurance processes which asked if the quality assurance processes should be combined into one quality assurance process for engineering education. All twenty-six participants answered this question. Twenty-four participants (92%) agreed that the quality assurance processes should be combined/aligned, one participant disagreed (4%) and one participant was unsure (4%). The methodology of how this could be achieved caused greater division among the participants. Twelve participants (46%) expressed a preference for the accreditation process to be incorporated into the programmatic review process, two participants (8%) suggested that the programmatic review process should be incorporated into the accreditation process, three participants (12%) stated that the two processes should remain separate and nine participants (34%) did not express any preference.

Question six explored the advantages of aligning/combining the processes. All twenty-six participants (100%) agreed that there are advantages to combining/aligning the processes. Sixteen (62%) of the participants suggested that there are savings in work effort, documentation and time and that work would not be duplicated. Seven participants (27%) suggested that the significant body of review activity would be reduced. Four participants (15%) agreed that the combination/alignment would ensure quality. Three participants (12%) suggested that programmes would be examined at the same point in time. Some other advantages were mentioned by a small number of participants as follows:

- Best of professional expertise available for the reviews;
- Combines technical and softer skills emphasis;
- Staff and stakeholder buy-in improved;
- Evidenced based approach is superior and would be beneficial to include;
- More time to focus on other initiatives in the department;
- Less administration and therefore less burdensome process.

Question seven enquired about the disadvantages to combining or aligning the processes. All twenty-six participants answered this question. Many of the responses were phrased to solve the disadvantage rather than stating the disadvantage. Eight participants (31%) suggested that a coherent alignment was needed to meet the objectives of both processes which were created in isolation from each other. Five participants (19%) mentioned that there are a range of programmes in Schools of Engineering, not just B.Eng. programmes, which may not be suitable for accreditation by Engineers Ireland. Four participants (15%) considered that discussion with the relevant stakeholders is required to agree responsibilities. Four participants (15%) stated that the strategic direction and reflection needs to be maintained in the new process and four participants (15%) declared that the new process may not be suitable for other professional associations, especially those with international partnerships. Some other disadvantages were mentioned by a small number of participants as follows:

- It would be a very onerous exercise with issues at granular and large scale;
- Engineers Ireland needs to demonstrate its independence to international partners;
- Difficulty in getting QQI and Engineers Ireland to agree on a single process;
- Specific programme feedback is appreciated by programme teams;
- The volume of documentation and its effects on industry participation;
- The programmatic review process is prospective and the accreditation process is retrospective;
- The advantages outweigh the disadvantages;
- Engineers Ireland accreditation is most relevant for civil engineering but less relevant for mechanical and electrical engineering.

As previously indicated, question eight was removed by the researcher to prevent bias.

Question nine explored the barriers to combining or aligning the processes. All twenty-six participants answered this question. Many of the responses were phrased to solve the barrier rather than stating the barrier. Five participants (19%) claimed that the accreditation evidence review should be a mini component of the combined/aligned process. Four participants (15%) suggested that everything needs agreement between QQI, HEIs and Engineers Ireland to create a focus, framework and protocol. Four participants (15%) indicated that there will be an enormous workload in mapping to the accreditation criteria and programme improvement in the same timeline. Three participants (12%) confirmed that there is strong merit in combining the processes but the depth of review is different for both processes.

A few other barriers were mentioned by a small number of participants as follows:

- The programmatic review often involves a school plan one year in advance of the programme reviews;
- The programmatic review is a prospective process and the Engineers Ireland accreditation process is retrospective;
- Interviews with stakeholders and students are programme specific;
- International standards and procedures need to be followed by some professional associations;
- QQI engineering standards and Engineers Ireland criteria should be similar;
- Approval by the HEI governing body and/or the Engineers Ireland Executive Committee needed;
- Engineers Ireland has a barrier requiring a C in Honours Maths for entry to engineering programmes seeking Chartered accreditation status;
- Duration of a combined or aligned process may be too long for panel members;
- The evidence review process may be difficult to include in the programmatic review process;
- Lack of consistency in panel membership and training;
- Managing the programmes not going forward for accreditation;
- Different professional associations in the engineering and construction field;
- Level eight programmes are the same in all HEIs but may have different Engineers Ireland accreditation outcomes;
- A single panel could have HEI nominees and professional association nominees.

Question ten enquired about the stakeholders for the two quality assurance processes. All twenty-six participants responded to this question. The participants were also asked to name stakeholders who should be included in these processes. The summary table gives the stakeholders suggested by each participant for both the programmatic review and accreditation processes separately. For the programmatic review process, 92% of participants mentioned employers, 84% students, 77% staff, 69% the HEI, 38% the engineering profession, 27% QQI and 27% mentioned graduates. For the Engineers Ireland accreditation process, 80% mentioned employers, 65% students, 65% staff, 65% Engineers Ireland, 58% the HEI, 54% the engineering profession and 30% mentioned graduates. The stakeholders are the same for both processes with the exception of QQI and Engineers Ireland.

The other stakeholders which could be included are also mentioned by the participants. For the programmatic review process these were as follows:

- Mathematics, engineering and science teachers at second level schools;
- Student union representatives;
- International students;
- Prospective students;
- Alumni;
- Higher Education Authority (HEA);
- Other HEIs;
- Wider society.

For the Engineers Ireland accreditation process, the other stakeholders mentioned by the participants are:

- Prospective students and guidance counsellors;
- Regional authorities;
- Mathematics, engineering and science second level teachers;
- Parents;
- Alumni;
- Wider society.

There appears to be support for including a broader range of stakeholders in both processes.

Question eleven explored whether the cyclical review periods of the programmatic review and accreditation processes could be synchronised. All twenty-six participants (100%) agreed that it would be possible to synchronise the cyclical review periods of the two processes. However, there was some variation on the proposed timeline for this cyclical review period with seven years considered too long and three years too short. Thirteen participants (50%) agreed that five years was the appropriate cyclical review period, five participants (19%) suggested that there should be an interim review for programmes in technology areas where programme content is changing rapidly (Information Technology), no participant suggested seven years and ten participants (38%) did not suggest any time period. Some barriers to achieving this synchronisation was mentioned such as the need for an agreement between Engineers Ireland and the HEIs, accreditation fee structure, new programmes and programmes that achieve one-year or three-year accreditation.

Question twelve examined whether the new process should be voluntary or mandatory. All twenty-six participants responded to this question. Table 5.4 is the summary table.

Participant Code	Voluntary	Mandatory	Accreditation Part of PR	Relevant to Disciplines	HEI Choice
α					
β					
δ					
ε					
ζ					
ρ					
θ					
ϯ					
κ					
λ					
μ					
ν					
ξ					
π					
η					
σ					
τ					
φ					
χ					
ψ					
ω					
ς					
ϐ					
϶					
Ϫ					
ϰ					
Total	**18 (69%)**	**8 (31%)**	**10 (39%)**	**7 (27%)**	**8 (31%)**

Table 5.4: Round One Question Twelve Summary Table

Eighteen participants (69%) opted for the combined/aligned process to be voluntary and eight participants (31%) selected mandatory. Ten participants (39%) mentioned that the Engineers Ireland process could be part of the programmatic review process and seven participants (27%) claimed that it depended on its relevance to the discipline of engineering. Eight participants (31%) declared that it should be the HEI choice whether to put programmes forward for accreditation. The participants revealed four reasons why programmes are not put forward for accreditation as follows:

- New programme – no graduates from the programme;
- The NFQ level of the programme is not compatible with the professional title level of accreditation awarded;
- The programme is accredited by UK professional associations;
- The programme is outside the norm (non-standard entry, international students).

Question thirteen considered how the agenda for the site visit would change for the new process. Four participants did not respond to this question. Five categories were identified and eighteen participants (82%) were in favour of an aligned process where one process immediately follows the other process. Fourteen participants (64%) mentioned that the accreditation processes could be embedded into the programmatic review process. Nine participants (41%) suggested that the processes overlap. Eight participants (36%) argued that additional time will be required to complete both processes.

Question fourteen examined whether the evidence-based assessment could be incorporated into the revised process. Twenty participants responded to this question and all (100%) agreed that the evidence-based assessment could be incorporated. Five participants (25%) agreed that aligned sessions could be implemented and five participants (25%) argued that the depth of review is broader in the programmatic review process.

Question fifteen considered the responsibility of the processes in the combined/aligned scenario. All twenty-six participants responded to this question. Six categories of participant response were identified. Fourteen participants (54%) suggested that there is shared responsibility. Fourteen participants (54%) argue that there should be an agreed process between the HEI and Engineers Ireland. Eight participants (31%) highlighted that the HEI cannot give away its authority or responsibility for the quality assurance of its programmes. Six participants (23%) concurred that accreditation is exclusively the responsibility of Engineers Ireland under statute.

Question sixteen queried how communication could be managed in a combined/aligned process. Three registrars did not respond to this question. Eight participants (35%) suggested that the Head of Faculty/Head of Department would be the appropriate person to liaise between the organisations. Eight participants (35%) suggested that it should be agreed between the HEI and Engineers Ireland. Three participants (13%) suggested the HEI Registrar and three participants (13%) suggested the programme team. In terms of the production of reports, nine participants (39%) suggested that there should be two reports and four participants (17%) suggested that there should be one report. Eleven participants (48%) declared that the Engineers Ireland accreditation report could be included in an annex to the programmatic review report and seven participants (27%) stated that the programmatic review report should be sent to the Engineers Ireland Accreditation Board.

Question seventeen reviewed the two independent outcomes of the processes which are validation and accreditation. All twenty-six participants answered this question. Nineteen of the participants (73%) agreed that there should be two outcomes, validation and accreditation, which are independent of each other. Five participants (19%) opted for a single outcome from a single process where the programme is reviewed academically and professionally at the same time. Two participants (8%) selected one process but the two outcomes remain.

Question eighteen allowed the participants to provide any information they considered appropriate to the research study. Twenty-four of the research participants made a comment under this heading. A small selection of the comments are as follows:

- Your investigation of this topic is long overdue, at least to assess the viability of it. A worthwhile body of research;
- Panel composition and training is very important. Some guidance on panel member training, knowledge and competence would be useful;
- We should align the Engineers Ireland criteria more closely with the QQI engineering award standards in terms of intended outcomes or objectives;
- There is a lot of crossover between what is covered in the programmatic review and accreditation processes. Any reduction would be helpful.

When all eighteen questions were analysed, the analysis by theme began. The categories from each question were reviewed to determine if they were the initial emerging themes of the research.

5.3 Round One Analysis by Theme

5.3.1 Individual Question Analysis by Theme

The *analysis by theme* was carried out in three phases. Each phase needed to be completed before the next phase could begin as the information gained from one phase informed the next phase of the analysis. It is a feature of the Delphi technique that it is not considered possible to get a true reflection of the data without going through this in-depth, time consuming and close inspection of the interview material. The three phases of the analysis by theme were:

- Individual question analysis by theme and noting any supporting comments and outliers. The percentage of instances (number of participants) who mentioned each theme was noted. Significant instances (greater than 25%) were highlighted and brought to the next stage of the analysis;
- Cross referencing the individual question themes across the eighteen questions and noting the revised percentage of instances in which each theme occurred. Significant instances (greater than 25%) were highlighted;
- The emergence of the overarching themes across all the questions, grouped into the themes referring to the existing processes and the themes which referred to a potential revised process.

This analysis generated a lot of documentation and corresponding mathematical percentages for the number of participants who mentioned a particular theme during their interview. To facilitate data reduction, a decision was made to deem anything greater than 25% of participants mentioning a particular theme as significant as it was mentioned by more than six participants. Some data could fit more than one theme but that did not occur often. All data, views and perspectives from the interviews were categorised under each theme, irrespective of its relevance to the question posed, so that no data was lost during the analysis.

The category information on the individual question summary tables, discussed in Section 5.2.3 of this thesis, was re-examined to identify the themes. Significant instances of occurrence of a theme (greater than 25%) were noted and highlighted for each of the eighteen questions. At this stage in the analysis the themes were identified within questions, but it was obvious that most themes appeared in a number of other questions and an examination across all questions needed to be carried out to get the true estimate of the incidence of occurrence for each theme.

5.3.2 Cross Referencing of Individual Question Themes Across all Questions

The themes identified on an individual question basis were then sought across the responses from the entire eighteen questions. The participant views analysis, section 5.2.2 of this thesis, was particularly helpful for this cross referencing. This required a systematic review of all data on an individual theme by theme basis. The mathematical estimation of the incidence of occurrence of each theme and every participant view was systematically calculated after checking each of the eighteen question responses. The participants who contributed to the view were noted. Table 5.5 gives the outcome of this analysis for question twelve.

Thematic Area	Participant Code	Participant Views Within the Theme	Instances (%)
Mandatory or voluntary accreditation		Voluntary – Should not be imposed	69.0 *
		Mandatory – removes confusion	31.0 *
		Accreditation process part of programmatic review process	39.0 *
		Relevance to disciplines of engineering	27.0 *
		HEI choice – option to apply for accreditation	31.0 *
Programmes not going forward for accreditation	Ϫ,χ,ƚ	New programmes need graduates	12.0
	Ϫ,μ,τ	Level of programme versus professional title achieved	12.0
	Ϫ,μ	UK professional association provides accreditation	8.0
	ϭ	Programme outside the norm	4.0
Participant views	Ϫ,ϭ,ς,ψ,φ,ρ,ƚ	The voluntary nature of accreditation not compromised by linking the processes	35.0 *
	,ξ,α	Combined into one process equates to a mandatory process	15.0
			15.0
	Ϫ,κ,Э,β	Engineers Ireland representatives on the programmatic review panel	12.0
	Ϫ,β,Э,κ	Engineering programmes benchmarked to a level of professional competence	8.0
			8.0
	η,χ,ς	Question of authority, responsibility and legality	8.0
	τ,α	External vigilance important	4.0
	ρ,π	Separate professional education from general education	4.0
	Ϫ,χ	Mergers (TU) raises additional issues	4.0
	ν	Not everybody appreciates accreditation – resistance in HEI	
	π		
	π	IEA agreements set accreditation standards and procedures	

Table 5.5: Question Twelve Emerging Themes Across all Questions ** Denotes Significant*

5.3.3 Emergence of Overarching Themes from Round One

Initially, the analysis was completed on a question by question basis but it became clear during this inspection of the data that there were other categories that emerged across the questions and were mentioned by a significant number of participants. The non-question categories that emerged from the interviews were as follows:

- the quality assurance processes – overview of both processes;
- broader focus - programmatic review has a broader focus than the Engineers Ireland accreditation process;
- a new model - alignment or combination of the quality assurance processes;
- work and effort – work involved in conducting the processes;
- frequency of occurrence – how often each process occurs;
- programmes not accredited by Engineers Ireland – range of programmes in faculties of engineering;
- validation and accreditation objectives – QQI Engineering Award Standards and Engineers Ireland accreditation criteria;
- synchronising of the review cycles – can the processes occur at the same time;
- panel membership – constituents of the programmatic review and accreditation panels;
- validation but not accreditation – the engineering programme can be validated but not achieve accreditation;
- considerable overlap between the processes – commonalities across processes;
- prospective and retrospective processes – reviewing programmes with a forward and backward lens.

Appendix N of this thesis gives the overarching themes from all the round one analyses. When the overarching themes were identified, the information was used to assist with the development of the round two questionnaire for distribution to the research participants.

Table 5.6 gives an example of the analysis for the *validation and accreditation objectives* theme. Fifteen (58%) of the twenty-six participants mentioned this theme.

Participant Code	Participant Views Within the Theme	Instances (%)
β,π,ς,ϰ	Objectives created in isolation from each other by QQI/EI	15.0
ς,α,δ	Get a shared understanding of engineering degree objectives	12.0
δ,κ,π	One collaborative process agreed between QQI, HEIs, and Engineers Ireland rather than two independent processes	12.0
δ,κ,ϰ	Align Engineers Ireland accreditation criteria and QQI engineering award standards for objectives	12.0
λ,π	QQI, HEI, Engineers Ireland accreditation and programmatic review requirements do not coincide at present	8.0
σ,κ	QQI engineering standards need to match the accreditation focus	8.0
ϕ,μ	Review current objectives to create a single set of requirements	8.0
η	Useful to align objectives and mapping of processes	4.0
β	Academic Council need to agree the full range of programme outcomes for the appropriate professional title level	4.0
δ	Scope to look at the re-alignment of QQI and Engineers Ireland objectives/criteria and outcomes	4.0
ϰ	Align schedules to suit the objectives of programmatic review and accreditation	4.0
ζ	Mapping exercise between the quality assurance standards of both processes to identify gaps	4.0
ω	Programme outcomes need to be the same for both processes	4.0
ν	Need alignment on standards/objectives	4.0

Table 5.6: Validation and Accreditation Objectives Overarching Theme

5.4 Round One Narrative Summaries

5.4.1 Narrative Summaries by Question

All the data from the various tables were gathered into coherent documents, showing all the analysed participant data, which would be readily available for inspection when the analyses from rounds two and three were complete. The creation of these narrative summary documents occurred in two steps:

- The creation of narrative summaries by question;
- The creation of a comprehensive overall narrative summary by theme.

The overarching emergent themes from the round one analysis for each question were used to create the narrative summaries by question. For each question, there is a table showing the emergent theme information and the incidences of occurrence in percentage terms. Each emergent theme was then considered separately in terms of frequency of occurrence and a discussion of the participant groups that mentioned the themes. Any other trend was also noted and discussed.

Responses outside the emergent themes that were mentioned during the interviews were captured in a list to ensure that all the relevant data was available during the analysis. The frequency of participant mentions of these outliers was also shown. A narrative was then created from this list of outliers to explain them.

For question twelve, all of the information provided in Table 5.5 is included in the narrative summary for this question. Table 5.7 and Table 5.8 provide the question twelve narrative on *emergent themes* and the narrative on *the responses outside the emergent themes*. The narrative summaries allow for examination of each theme by participant group type and the engineering disciplines grouped into built environment & civil engineering and mechanical & electrical engineering. The narrative summaries by question for a selection of the round one questions are available in Appendix O.

Theme	Participant Mentions	Group Type Comment
Voluntary – not imposed	18 of 26	Strong support from all group types
Mandatory	8 of 26	Some support from all group types
Accreditation part of the programmatic review process	10 of 26	Some support from all group types except Heads of Faculty. Popular with Registrars and Staff
HEI choice to apply for accreditation	8 of 26	Some support from all group types especially Heads of Faculty
Relevance to disciplines of engineering	7 of 26	Some support from all group types except Professional Association Representatives. Popular with Registrars

Table 5.7: Question Twelve Narrative on Emergent Themes

To move from a voluntary accreditation process to a mandatory accreditation process comes back to the questions of authority and responsibility. Who is responsible for what and where ultimately legally this responsibility lies? The voluntary nature of accreditation may not be compromised by linking the two processes. If a programme is not going for accreditation, the programmatic review is completed in the normal way. If a programme applies for accreditation, then the essential compulsory elements are included as part of the programmatic review process. Two fully integrated processes make the accreditation process mandatory which can remove the dilemma of whether a programme is accredited. The freedom should exist for some programmes to apply for accreditation and others not. International mutual recognition agreements, where qualifications are recognised in other countries makes accreditation more important. Technological University mergers are raising questions around accredited and unaccredited programmes as some programmes are accredited without the mathematics requirement. Not everybody appreciates Engineers Ireland accreditation in the HEIs as they may not see the relevance and this can create internal resistance. International mutual recognition agreements set the standards and the procedures that are followed for accreditation. Ideally, all engineers should follow an accredited engineering programme and go on to gain chartered membership of their professional association. Engineers Ireland benchmarks engineering programmes to a level of professional competence.

Table 5.8: Question Twelve Narrative on Responses Outside the Emergent Themes

5.4.2 Narrative Summaries by Theme

The round one research outcomes were established in the narrative summaries for each individual question and these were collected together into a two-dimensional table showing the question number, emergent theme, frequency of occurrence of the theme among the research participants and broken down by group type and engineering discipline. Table 5.9 illustrates the questions twelve and thirteen portion of this narrative summary by theme document and the complete document for round one is given in Appendix O of this thesis.

5.5 Conclusion and Link to the Research Objectives

The research findings for this study are spread across three chapters of this thesis to reflect the three phases of data collection. Each phase of the data collection, Delphi technique rounds, are discrete elements for analysis and must be complete before the data collection can move to the next phase. The first round is a semi-structured interview.

Q	Emergent Theme	Participant Mentions	Reg	Prof. Asso.	HoF	HoF	HoD	HoD	Staff	Staff
				Reps	M & E	C	M & E	C	M & E	C
12	Voluntary	69%	5	1	1	2	2	2	3	2
	Mandatory	31%	1	1	1		1	1	1	2
	ACC in PR	39%	3	1			1	1	2	2
	HEI choice	31%	2		1	2		1	1	1
	Relevance	27%	4		1		1			1
13	Aligned Agenda	82%	1	1	2	1	3	3	3	4
	ACC in PR	64%	2	1		1	1	3	2	4
	Overlaps	41%		1		1	1	2	2	2
	Extra time	36%		1	2			3	1	1
	Forward and backward view	14%						1		2

Table 5.9: Round One Sample of Narrative Summary by Theme Document

C = Civil Engineering and the Built Environment   M & E = Mechanical and Electrical Engineering

= Registrars (Governance)
= Professional Association Representatives
= Head of Faculty/School - mechanical/electrical engineering
= Head of Faculty/School - built environment/civil engineering
= Head of Department - mechanical/electrical engineering
= Head of Department - built environment/civil engineering
= Academic Staff – mechanical/electrical engineering
= Academic Staff – built environment/civil engineering

The round one analysis commenced with the analysis by question where the interview data was transcribed and then reorganised on a question by question basis. The participants' views were extracted from this material for each question separately. Similar views were grouped together to create categories. The research findings by question were described. Comparison across all eighteen questions resulted in a list of emerging themes.

Question twelve was selected to demonstrate how the analysis was carried out for the voluntary or mandatory accreditation theme. This theme appeared again in the questionnaire and the round three interview questions. The reader can follow this theme through the three rounds of analysis of the research.

The analysis by theme commenced with a review of the list of emerging themes and linking them with the participant responses. A close examination of the data when cross referencing the themes and all participants' views yielded additional overarching themes outside of the original questions. Sub-themes were identified within the overall question themes and these were examined for participant frequency of occurrence. If 25% or more of the participants mentioned a theme/sub-theme, it was considered by the researcher to be significant and brought to the next stage of the analysis.

To complete the analysis, all the elements of the analysis were gathered together into narrative summaries by individual questions and an overall narrative summary across all the questions.

The themes were further placed into those relating to the existing quality assurance processes (programmatic review and accreditation) and those relating to a new revised process(es). Table 5.10 gives the round one table of overarching themes split into existing and revised processes.

Existing Processes	Revised Process(es)
Purpose of the quality assurance processes	Align or combine?
Mandatory versus voluntary accreditation process	Independence of the outcomes (validation and accreditation)
Prospective versus retrospective focus	Advantages, disadvantages and barriers to aligning/combining the processes
Synchronising of the review cycles	Methods of aligning/combining the processes
Similarities between the two processes and the effect on workload	Revised process site visit agenda
Validation and accreditation objectives	Responsibilities of stakeholders in the revised process
Programmes not accredited by Engineers Ireland	Communications management between all the stakeholders and across organisations
Panel membership	

Table 5.10: Round One Table of Overarching Themes

It was clear that there is considerable interest expressed by the participants in aligning or combining the quality assurance processes, as determined in the recent reports outlined in the literature review (chapter two), but the method of alignment was the question participants struggled to answer as it was linked to the voluntary or mandatory accreditation question.

Participants' responses related to improvements of the existing processes were categorised into the existing processes part of the table and suggestions for a new process(es) were categorised into the revised process(es) part of the table. Panel membership issues gathered a lot of comments. Programmes not accredited by Engineers Ireland was mentioned by a much higher percentage of participants than the researcher would have anticipated. Similarities between the processes and the effect on workload reflected the historical view of the processes outlined in chapter two.

Nine research objectives were outlined in chapter one of this research thesis to address the overall research question. The nine objectives explored the willingness of the stakeholders to engage with the concept of bringing the quality assurance processes into closer alignment, the advantages, disadvantages and barriers to the concept, the responsibilities and influence of the stakeholders, the adoption of the evidence-based approach, whether accreditation should be voluntary or mandatory, synchronisation of the review cycles, aligning of validation and accreditation objectives, communication management and independent process outcomes.

These research objectives were compared with the round one questions and the overarching themes from the round one analysis. Table 5.11 provides a summary of the link between the research objectives, the round one research questions and the round one overarching themes. The obvious connections between the interview questions, research objectives and overarching themes can be seen in Table 5.11. The research objectives will be further discussed in chapter eight.

Chapter six provides the research findings for the Delphi round two questionnaire. Twenty-four participants completed the questionnaire online and the findings are outlined in the next chapter.

Round One Overarching Theme	Interview Question Number (s)	Research Objective Number (s)
Purpose of the quality assurance processes	3, 4	1, 3, 9
Mandatory versus voluntary accreditation process	5, 12	3, 5, 9
Prospective versus retrospective focus	5, 14	3
Synchronising of the review cycles	11	6, 8
Similarities between the two processes and the effect on workload	3, 5	3, 6
Validation and accreditation objectives	5, 14	1, 7, 9
Programmes not accredited by Engineers Ireland	14, 15	3
Panel membership	14, 15	3, 4, 8
Align or combine	5, 15	1, 4, 9
Independence of the outcomes (validation and accreditation)	17	3, 9
Advantages, disadvantages and barriers to aligning / combining the processes	4, 6, 7, 9, 15	2, 9
Methods of aligning / combining the processes	5, 15, 16, 17	1, 4, 9
Revised process site visit agenda	13	3, 6, 8
Responsibilities of stakeholders in the revised process	10, 12, 15, 16	1, 3, 7, 8, 9
Communications management between all the stakeholders and across organisations	15, 16	1, 3, 8, 9

Table 5.11: Link Between Round One Overarching Themes, Round One Interview Questions and the Research Objectives

Chapter 6: Delphi Technique Round Two Questionnaire Analysis

6.1 Overview

Chapters five, six and seven will provide the research findings for this study. Chapter six presents the findings for the round two questionnaire which was analysed in a different way to the round one interviews as the nature of the data collection method differed but followed an overall analysis by question and then theme. Further breakdown by group type and engineering discipline followed but is only an indicator of trend as the number of research participants in each category was small.

Participants were asked to complete a questionnaire online using the '*Survey Monkey*' web service for round two of data collection. The preparation of the questionnaire from the round one interviews, and its uploading to Survey Monkey, was described in chapter four. Survey Monkey has an analysis function which provides initial statistical data, insights and trends from the completed questionnaires which allowed comparison with the researcher's findings.

The content of this Delphi technique round two questionnaire analysis is organised into five streams and follows the questionnaire analysis by question, the questionnaire analysis by theme including the deeper analysis by group type and engineering discipline, the narrative summaries by question and theme, the identification of the themes which had achieved consensus and the themes which needed further consideration and concludes with a summary of the outcomes from round two. Analysis within a stream involved a number of stages, in most instances.

The process involved in the analysis by question is described in detail in stream two together with samples of the analysis. Stream three follows the same approach for the analysis by theme and provides an in-depth analysis by group type and engineering discipline. The approach to the generation of the narrative summaries by question and theme is set out in stream four together with samples of this analysis. Stream five describes how the research outcomes were extracted from the analysis by determining participant consensus. The chapter concludes with a summary of the agreed and unresolved themes from the Delphi technique round two analysis and their link to the research objectives. These unresolved themes were used to assist with the development of the round three interview questions.

6.2 Round Two Analysis by Question

6.2.1 Survey Monkey Data Insights and Questionnaire Summaries

Twenty-four of the round one research participants responded to the Survey Monkey questionnaire. As there were twenty-six participants interviewed in round one, the response rate was over 92%.

Survey Monkey has an inherent data analysis function which provided insights and trends by week of the questionnaire responses. The insights confirmed that there were twenty-four participant responses with a 100% completion rate and the average time spent was twenty-two minutes and three seconds. The trends were provided graphically per question and sub-question on a weekly basis, but were checked by the researcher, and are better illustrated in Section 6.2.4 of this chapter. The question summaries provided by Survey Monkey gave a histogram diagram portrayal and a statistical breakdown of participant responses on a question by question basis. This information has been verified and captured in a tabular format for all questions, by the researcher, in Section 6.2.3 of this chapter.

6.2.2 Individual Analysis of the Eighty-Three Sub-Questions in the Questionnaire

There are eighty-five items in the questionnaire divided into seventeen theme areas/questions from the round one interviews. Two of the items are the opening question asking the participant's name, and the closing question asking for any further comments or concerns. The opening and closing questions do not form part of the analysis by question. Therefore, there were eighty-three items/sub-questions analysed over seventeen themed areas by twenty-four participants which equates to 1992 responses to be analysed.

The individual analysis of each of the eighty-three sub-questions involved determining the number of participants who responded to each of the five options of:

- Strongly disagree;
- Disagree;
- Neither agree not disagree;
- Agree;
- Strongly agree.

From these figures, the percentage of respondents for each of the five response options were calculated. In addition, the number of positive, neutral and negative responses were collated, in participant number and percentage terms, for agree and strongly agree, neither agree nor disagree and disagree or strongly disagree.

From the data, a conclusion in terms of positive responses was determined and the number of negative responses noted.

Question three in the questionnaire pertains to '*a voluntary or mandatory accreditation process*' and corresponds to the question twelve example from round one. Question three has three sub-questions as follows:

- Question 3(a) – The Engineers Ireland accreditation process should remain voluntary.
- Question 3(b) – A mandatory Engineers Ireland accreditation process would remove confusion as to which engineering programmes are accredited by Engineers Ireland.
- Question 3(c) – Combining the two processes into a single process would make the Engineers Ireland accreditation process mandatory for all engineering programmes.

Table 6.1, Table 6.2 and Table 6.3 are samples of the individual question analysis for questions 3(a), 3(b) and 3(c) respectively. A small selection of the eighty-three individual question analyses are given in Appendix P of this thesis.

Response Options	Number of Participants	Percentage of Participants
Strongly Disagree	2	8.33
Disagree	5	20.83
Neither Agree nor Disagree	3	12.50
Agree	8	33.34 *
Strongly Agree	6	25.00 *
Total	24	100.00
Agree and Strongly Agree	14	58.33*
Neither Agree nor Disagree	3	12.50
Disagree and Strongly Disagree	7	29.17*
Two participants strongly disagreed and five disagreed		
58.33% either agree or strongly agree with 12.5% undecided		

Table 6.1: Round Two Q3(a) Individual Question Analysis on Whether Accreditation Should Remain Voluntary

** Denotes Significant*

Response Options	Number of Participants	Percentage of Participants
Strongly Disagree	1	4.17
Disagree	6	25.00 *
Neither Agree nor Disagree	5	20.83
Agree	5	20.83
Strongly Agree	7	29.17 *
Total	24	100.00
Agree and Strongly Agree	12	50.00 *
Neither Agree nor Disagree	5	20.83
Disagree and Strongly Disagree	7	29.17 *
One participant strongly disagreed and six disagreed		
50.00% either agree or strongly agree with 20.83% undecided		

Table 6.2: Round Two Q3(b) Individual Question Analysis on a Mandatory Accreditation Process Removing Confusion as to Which Programmes are Accredited by Engineers Ireland

Response Options	Number of Participants	Percentage of Participants
Strongly Disagree	1	4.17
Disagree	3	12.50
Neither Agree nor Disagree	2	8.33
Agree	10	41.67 *
Strongly Agree	8	33.33 *
Total	24	100.00
Agree and Strongly Agree	18	75.00 *
Neither Agree nor Disagree	2	8.33
Disagree and Strongly Disagree	4	16.67
One participant strongly disagreed and three disagreed		
75.00% either agree or strongly agree with 8.33% undecided		

Table 6.3: Round Two Q3(c) Individual Question Analysis on the Combined Option Making the Engineers Ireland Process Mandatory

It should be noted that this theme was selected as it has a greater number of participants with different views which eventually led to this question being asked again of participants in round three. Most questions reported strong agreement from the research participants but a small number of items/sub-questions elicited a variety of responses. Those sub-questions were further considered in round three.

6.2.3 Percentage Responses for Positive, Neutral and Negative Response Options

The percentage participant response data from the eighty-three individual sub-questions was pulled together into two summary documents:

- Showing positive, neutral and negative responses (including the neutral data);
- Showing positive and negative responses (excluding the neutral data).

Bringing together agree and strongly agree, disagree and strongly disagree and neither agree nor disagree separately shows the support, disagreement and neutral view of the participants to the questions posed in the questionnaire. Table 6.4 shows a sample of the summary document which includes the neutral data. The complete summary document which includes the neutral data is given in Appendix Q of this thesis.

Question Number	A & SA Number	A & SA %	D & SD Number	D & SD %	N A/D Number	N A/D %
2a	21	87.50	1	4.17	2	8.33
2b	21	87.50	0	0.00	3	12.50
2c	21	87.50	2	8.33	1	4.17
2d	23	95.83	0	0.00	1	4.17
2e	17	70.83	3	12.50	4	16.67
2f	22	91.67	1	4.17	1	4.17
2g	17	70.83	3	12.50	4	16.67
2h	21	87.50	0	0.00	3	12.50
2i	21	87.50	1	4.17	2	8.33
2j	15	62.50	2	8.33	7	29.17
3a	14	58.33	7	29.17	3	12.50
3b	12	50.00	7	29.17	5	20.83
3c	18	75.00	4	16.67	2	8.33
4a	22	91.67	1	4.17	1	4.17
4b	21	87.50	0	0.00	3	12.50
4c	22	91.67	0	0.00	2	8.33

Table 6.4: Sample of the Summary of Percentage Responses (Including the Neutral Data)

A & SA = Agreed or strongly agreed.   D & SD = Disagreed or strongly disagreed.

N A/D = Neither agreed nor disagreed (neutral data).

The overall response per sub-question was identified and the overall outcome for the data which included the neutral information was estimated as follows:

- 53 very positive responses – 75% to 100% of participants agreed or strongly agreed;
- 26 positive responses - 50% to 74% of participant agreed or strongly agreed;
- 4 negative responses - 0% to 49% of participants agreed or strongly agreed.

Table 6.5 shows a sample of the summary document which excludes the neutral data. This analysis was carried out to get a clearer picture of the positive responses versus the negative responses for all eighty-three items/sub-questions. This required a re-calculation of the percentages accordingly. The complete summary document which excludes the neutral data is given in Appendix Q of this thesis.

Question	A & SA	A & SA	D & SD	D & SD
Number	Number	%	Number	%
2a	21	95.45	1	4.55
2b	21	100.00	0	0.00
2c	21	91.30	2	8.70
2d	23	100.00	0	0.00
2e	17	85.00	3	15.00
2f	22	95.65	1	4.35
2g	17	85.00	3	15.00
2h	21	100.00	0	0.00
2i	21	95.45	1	4.55
2j	15	88.24	2	11.76
3a	14	66.67	7	33.33
3b	12	63.16	7	36.84
3c	18	81.82	4	18.18
4a	22	95.65	1	4.35
4b	21	100.00	0	0.00
4c	22	100.00	0	0.00

Table 6.5: Sample of the Summary of Percentage Responses (Excluding the Neutral Data)

A & SA = Agreed or strongly agreed.   D & SD = Disagreed or strongly disagreed.

The overall response per sub-question for the data which excluded the neutral information was estimated as follows:

- 70 very positive responses – 75% to 100% of participants agreed or strongly agreed;
- 11 positive responses - 50% t0 74% of participants agreed or strongly agreed;
- 2 negative responses - 0% to 49% of participants agreed or strongly agreed.

Table 6.6 provides the overall questionnaire responses for each question/theme. A high proportion of responses were positive and only a selection of responses was mixed or negative.

Q	Theme	Participant Questionnaire Responses
1	n/a	92% response rate. All participants provided their names.
2	Quality Assurance Process Overview	Very positive with only one sub-question where the number of participants who selected 'Neither Agree nor Disagree' exceeds four.
3	Mandatory or Voluntary Accreditation Process	Very mixed opinions but generally positive. Two subsections had seven participants each who disagreed with the question.
4	Prospective and Retrospective Processes	Very positive responses.
5	Review Cycles	Mixed opinions but mostly positive. Only one sub-question where the number of participants who disagreed exceeded four.
6	Similarities Between the Processes and its Effect on Workload	Very positive responses.
7	Validation and Accreditation Objectives	Positive responses. Only one sub-question where the number of participants who selected the neutral option exceeded four.
8	Engineering Programmes not accredited by Engineers Ireland	Very positive except for one sub-question where the number of participants who disagreed exceeded seven.
9	Panel Membership	Very positive. One sub-question elicited eight neutral responses.
10	Align or Combine?	Very positive. One sub-question elicited seven disagree responses and five neutral responses.
11	Independence of the Quality Assurance Outcomes	Very mixed responses but generally positive. All sub-questions had more than four participants give a disagree response or a neutral response.
12	Advantages to Aligning/Combining the Processes	Very positive responses.

13	Disadvantages to Aligning/Combining the Processes	Mixed responses but generally positive except for one sub-question.
14	Barriers to Aligning/Combining the Processes	Positive responses. One sub-question had six disagree responses and nine neutral responses.
15	Method of Alignment or Combination	Very mixed responses. Two sub-questions had at least ten disagree responses each.
16	Agenda	Very positive responses.
17	Responsibilities of Stakeholders	Very positive responses with one sub-question having five neutral responses.
18	Communications Management	Positive responses with one sub-question having five disagree responses and five neutral responses.
19	n/a	Seventeen participants answered this question. Seven participants skipped the question.

Table 6.6: Overall Questionnaire Responses for each Question/Theme

6.2.4 Cumulative Percentage Responses with Neutral Responses Included and Excluded

The cumulative positive (agree or strongly agree) responses were estimated to determine the number of instances when the positive response rate was higher than a particular percentage for the inclusion and exclusion of the neutral data (See Table 6.7).

Percentage	**Instances**	**Instances**	**Cumulative Instances**	**Cumulative Instances**	**Cumulative Instances**	**Cumulative Instances**
Range	**With N A/D Data**	**Without N A/D Data**	**With N A/D Data**	**With N A/D Data**	**Without N A/D Data**	**Without N A/D Data**
			Number	%	Number	%
100	0	22	0	0	22	26.5
100 - 90	20	28	20	24	50	60
90 - 80	24	16	44	53	66	79.5
80 - 70	15	6	59	71	72	87
70 - 60	8	8	67	81	80	96
60 - 50	12	2	79	95	82	99
50 - 0	4	1	83	100	83	100
Total	***83***	***83***	***83***	***100***	***83***	***100***

Table 6.7: Cumulative Positive Responses *N A/D = Neither Agree nor Disagree*

For the scenario where the neutral data is included:

- 24% of the questions incurred a positive response rate of over 90%;
- 53% of the questions incurred a positive responses rate of over 80%;
- 71% of the questions incurred a positive response rate of over 70%;
- 81% of the questions incurred a positive response rate of over 60%;
- 95% of the questions incurred a positive response rate of over 50%;
- Only 5% of the questions incurred a positive response rate of under 50%.

For the scenario where the neutral data is excluded:

- 26.4% (22 sub-questions) achieved a positive response rate of 100%;
- 60% of the questions incurred a positive response rate of over 90%;
- 80% of the questions incurred a positive response rate of over 80%;
- 87% of the questions incurred a positive response rate of over 70%;
- 96% of the questions incurred a positive response rate of over 60%;
- 99% of the questions incurred a positive response rate of over 50%;
- Only 1% of the questions incurred a positive response rate of under 50%.

This analysis, whether considering the neutral data or not, demonstrates the very high proportion of consensus and agreement amongst the participant responses. Participants disagreed on average with only five percent of the questionnaire items and this reduces to one percent if the neutral data is not considered.

6.2.5 Full Range of Participant Responses

Each item was carefully reviewed in order to capture how each participant answered each sub-question. A two-dimensional table was prepared to identify how each of the items/sub-questions were answered and by whom in great detail. All of the questionnaire response information is captured in this table and it has been carefully cross-checked for accuracy. The agree and strongly agree responses are separated as are the disagree and strongly disagree responses. The participant codes were used to keep the responses anonymous and to set up the data for the next level of analysis. Table 6.8 shows a small sample of this table for question three. The full table is given in Appendix R of this thesis.

Q	A & SA	A & SA	A & SA	D & SD	D & SD	D & SD
	No.	Agree	Strongly Agree	No.	Disagree	Strongly Disagree
3a	14	β,δ,ϕ,ζ,λ,ρ,π,ν	ϐ,Э,μ,τ,ε,ƭ	7	Ƛ,η,κ,ς,θ	χ,ω
3b	12	μ,π,ζ,ϕ,σ	χ,ρ,η,ω,Ƛ,ς,θ	7	ϐ,α,Э,ƭ,τ,ν	ε
3c	18	Ƛ,χ,ϐ,σ,μ,η,π,ε,ƭ,ς	ξ,δ,α,β,ζ,ω,κ,θ	4	ϕ,ρ,ν	τ

Table 6.8: Round Two Full Range of Participant Responses

A & SA = Agreed or strongly agreed.   D & SD = Disagreed or strongly disagreed.

Table 6.8 highlights the volume of positive responses versus negative responses. It can be clearly seen that there are significantly more positive responses than negative responses. The information in this table was used to conduct the deeper analysis by group type and engineering discipline as all the information needed can be found in this one document.

6.2.6 Participant Selections Frequency

A participant selections frequency table (Table 6.9) was prepared to give a breakdown, per participant, of how many times they selected from the five options of:

- Strongly disagree;
- Disagree;
- Neither agree nor disagree;
- Agree;
- Strongly agree.

Table 6.9 highlights the total number of responses for each of the five response options.

Participant Code	Agree	Strongly Agree	Disagree	Strongly Disagree	Neither Agree nor Disagree
α	36	26	9	2	10
β	36	29	4	4	10
δ	42	19	10	4	8
ε	20	52	7	3	1
ζ	51	24	2	0	6
ρ	43	29	5	1	5
θ	33	26	10	1	13
ϯ	61	8	7	1	6
κ	29	35	4	1	14
λ	34	25	4	1	17
μ	51	13	4	0	15
ν	31	39	10	1	2
ξ	9	45	4	7	18
π	65	1	8	0	9
η	56	12	9	0	6
σ	19	47	3	1	13
τ	14	21	15	6	27
ϕ	55	15	9	1	3
χ	34	29	10	2	8
ω	33	39	4	2	5
ς	52	9	5	0	17
ϐ	16	2	15	10	40
Ͽ	41	7	13	0	22
Ϫ	17	54	9	1	2
Total	***880***	***606***	***180***	***49***	***277***

Table 6.9: Round Two Participant Selections Frequency

The breakdown for the frequency of response selection is given in Table 6.10.

Response Option	Number of Participant Responses	Average of Participant Responses	Standard Deviation of Participant Responses
Agree	808	37.0	15.7
Strongly agree	606	25.0	15.4
Neither agree nor disagree	277	11.5	9.0
Disagree	180	7.5	3.7
Strongly disagree	49	2.0	2.5

Table 6.10: Round Two Participant Responses by Response Options Selected

The data highlights the strong agreement of the responses to the questions posed by the questionnaire and correlates well, and agrees with, the overarching themes from the round one interviews. Overall, the positive, negative and neutral responses are as follows:

- Positive responses = 880 + 606 = 1486 = 74.6%;
- Negative responses = 180 + 49 = 229 = 11.5%;
- Neutral responses = 277 = 277 = 13.9%.

6.2.7 'Neither Agree nor Disagree' Responses

All research participants selected the *'Neither Agree nor Disagree'* option at least once when answering the questionnaire. Participants may have selected this option because they found these sub-questions difficult to answer and/or were concerned about the answer to the question. A two-dimensional table was created showing which questions the participants selected to answer 'Neither Agree nor Disagree'. Some questions elicited this response from participants more than others and some participants selected this response more than others. The analysis made it possible to identify which sub-questions may have caused confusion, difficulty or lack of awareness of the issues discussed in the sub-question. It provides a guide for questions that were considered for clarification in the round three interviews. Table 6.11 provides a sample of this table but viewing the full document is necessary to see the trends. The complete table is given in Appendix R of this thesis.

Participant Code	Q3a	Q3b	Q3c	Q4a	Q4b	Q4c	Q5a	Q5b	Q5c	Q5d	Q5e
α											
β											
δ											
ε											
ζ											
ρ											
θ											
ϯ											
κ											
λ											
μ											
ν											
ξ											
π											
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σ											
τ											
ϕ											
χ											
ω											
ς											
ϐ											
϶											
Ϫ											

Table 6.11: Sample of Sub-questions Answered 'Neither Agree nor Disagree'

The colours indicate the participant group type (registrar, head of faculty, staff, etc).

In the questionnaire analysis by question, the aim was to extract the main findings from the individual analysis of the eighty-three sub-questions, the collation of percentage responses for positive, negative and neutral participant responses, examining the full range of participant answers, determining the participant responses selections frequency and concluded by identifying the sub-questions which were selected by participants for a neutral response. The questionnaire was then analysed by theme.

6.3 Round Two Analysis by Theme

6.3.1 Individual Question Analysis by Theme

The analysis by theme was carried out on eighty-three items/sub-questions over seventeen theme areas. Responses to question nineteen was also summarised into concerns. The responses to the sub-questions were summarised in percentage terms for the positive, neutral and negative responses. An overall conclusion was presented per theme area. An example of the *Mandatory or Voluntary Engineers Ireland Accreditation Process* theme is given in Table 6.12. Appendix S of this thesis has the outcomes for a selection of the other theme areas. All participants answered all sub-questions in question three.

Q	Sub-question	A & SA	N A/D	D & SD
		%	%	%
3(a)	The Engineers Ireland accreditation process should remain voluntary (not imposed)?	58.33	12.50	29.17
3(b)	A mandatory Engineers Ireland accreditation process would remove confusion as to which engineering programmes are accredited by Engineers Ireland?	50.00	20.83	29.17
3(c)	Combining the two processes into a single process would make the Engineers Ireland accreditation process mandatory for all engineering programmes?	75.00	8.33	16.67
	Conclusion: A mixed response was gathered for all three sub-questions in question three although mostly positive. There is still mixed views as to whether the Engineers Ireland accreditation process should be mandatory or voluntary. Participants found this question challenging to answer in the round one interviews.			

Table 6.12: Question Three Analysis by Theme

6.3.2 Analysis by Group Type and Engineering Discipline Area

A deeper analysis per theme was prepared to identify preferences by group type and engineering discipline. For each theme area, the first phase was to create a colour coded system to enable easy identification of the group types and engineering disciplines on a two-dimensional chart. The chart illustrated each participant's response to each sub-question. Each group type was assigned a colour. Where there were different engineering disciplines within the group type, different hues of the colour were used on the chart.

Table 6.13 shows the chart for question three. Appendix T of this thesis gives the charts for a selection of the other theme areas.

	3a	3a	3a	3a	3a	3b	3b	3b	3b	3b	3c	3c	3c	3c	3c
Code	**SD**	**D**	**N**	**A**	**SA**	**SD**	**D**	**N**	**A**	**SA**	**SD**	**D**	**N**	**A**	**SA**
α															
β															
δ															
ε															
ζ															
ρ															
θ															
ɟ															
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Table 6.13: Question Three Analysis by Group Type and Engineering Discipline Chart

SD = Strongly disagree; D = Disagree; N = Neither agree nor disagree;

A = Agree; SA = Strongly agree.

= Registrars (Governance)
= Professional Association Representatives
= Head of Faculty/School - mechanical/electrical engineering
= Head of Faculty/School - built environment/civil engineering
= Head of Department - mechanical/electrical engineering
= Head of Department - built environment/civil engineering
= Academic Staff – mechanical/electrical engineering
= Academic Staff – built environment/civil engineering

Each of these charts were further analysed for the seventeen theme areas to compare and contrast between organisational level participants' views and engineering discipline participants' views. The sequence of analysis was as follows for each theme area:

- Overall impression per sub-question;
- Analysis by full groups – registrars, heads of faculty, etc.;
- Analysis by sub-groups – heads of faculty split into the engineering disciplines, etc.;
- Management versus staff view – registrars, heads of faculty, heads of department and academic staff;
- Analysis by mechanical/electrical engineering discipline -relevant heads of faculty, heads of department and academic staff;
- Analysis by built environment/civil engineering discipline – relevant heads of faculty, heads of department and academic staff;
- Responses outside the normal/negative responses.

A different colour code was used to describe the participants' responses for this analysis as shown below. The analysis by sub-groups also provides the information on the analysis for the mechanical/electrical engineering discipline and the analysis for the built environment /civil engineering discipline.

Very Positive
Positive
Mixed
Negative
Neutral

Tables 6.14 to 6.18 provides the tabular comparison and contrast colour analysis for question three by group type and engineering discipline per sub-question. Appendix T of this thesis gives the tables for a selection of the other theme areas.

Sub-Question	Overall Impression of Participant's Responses
3a	Mixed
3b	Mixed
3c	Positive

Table 6.14: Question Three Overall Impression of Participant's Responses per Sub-question

Sub-Question	Registrars	Professional Associations	Heads of Faculty/School	Heads of Department	Academic Staff
3a					
3b					
3c					

Table 6.15: Question Three Analysis by Full Groups Per Sub-question

Sub-Question	Heads of Faculty Mech & Elec	Heads of Department Mech & Elec	Academic Staff Mech & Elec	Heads of Faculty Built & Civil	Heads of Department Built & Civil	Academic Staff Built & Civil
3a						
3b						
3c						

Table 6.16: Question Three Analysis by Sub-groups and Engineering Discipline Division

Sub-Question	Management (Heads of Faculty/Department)	Academic Staff
3a		
3b		
3c		

Table 6.17: Question Three Management Versus Staff Participant Responses

Sub-Question	Negative Responses	Negative Responses
	Number	Participant
3a	7	Ϫ,θ,κ,η,ς,ω,χ
3b	7	α,ε,ϯ,ν,τ,ϐ,϶
3c	4	ρ,ν,τ,ϕ

Table 6.18: Question Three Negative Participant Responses

The overall impression for the items that the accreditation process should remain voluntary and that mandatory accreditation would remove confusion as to which engineering programmes are accredited by Engineers Ireland is a mixed participant response. The combined option making accreditation mandatory has a positive participant response. The registrars and professional association representatives were most supportive of question three and the academic staff the least positive. The Heads of Faculty and Heads of Department provided similar responses. The civil engineering management and staff gave more positive responses than the mechanical/electrical engineering management and staff. The mechanical/electrical Heads of Faculty were less supportive of this theme than the civil engineering Heads of Faculty. The management provided responses that were more positive than the academic staff. Eighteen negative responses to question three was one of the highest negative response rates of the nineteen questions asked in the questionnaire. There was a lot of mixed views which implied that further consideration was needed in round three.

6.4 Round Two Narrative Summaries

6.4.1 Narrative Summaries by Question

All the data from the various tables were next gathered into a coherent document which would be readily available for discussion when the analysis from round three was complete. The creation of these narrative summary documents occurred in two steps:

- The creation of narrative summaries by question;
- The creation of a comprehensive overall narrative summary by theme.

A new colour coded system was devised which would bring consistency between the analysis in rounds one, two and three so that the data could be easily compared across the three Delphi technique rounds.

The new colour coded system had similar *group types* of registrars, professional association representatives, heads of faculty/school, heads of department, academic staff and management (combined views of registrars, heads of faculty and heads of department).

The colour coded system also had a similar *engineering discipline* breakdown of heads of faculty/school (mechanical/electrical engineering), heads of department (mechanical/electrical engineering), academic staff (mechanical/electrical engineering), heads of faculty/school (built environment/civil engineering), heads of department (built environment/civil engineering) and academic staff (built environment/civil engineering).

The *colour code* applied is as follows:

	Very positive support for the theme
	Positive support for the theme
	Mixed support for the theme
	No view expressed for the theme
	Negative support for the theme
	Very negative support for the theme

The sub-questions were colour coded as indicated above into two-dimensional tables which also included the frequency of occurrence of the theme in the sub-question. For each question there is an overall indication of participant agreement with the theme and sub-questions, a table for group type and a table for engineering discipline. The colour coding was applied consistently across all the sub-questions as indicated in the next two paragraphs.

For the six Registrars and six Heads of Department, if one or two agreed the theme, it would be considered a negative response. If three agreed the theme it would be considered a mixed response. If four agreed the theme it would be considered a positive response and if five or six agreed the theme it would be a very positive response. If none of the Registrars or Heads of Department agreed the theme, it would be considered as ‘no view expressed’. The allocation of positive, negative or mixed response colours was also dependent on the number of neutral responses in the group type and whether the responses were agreed or strongly agreed. Differences between disagreed and strongly disagreed were also noted. The nuances were taken into consideration when applying the response colours.

For the five-academic staff, if one or two agreed the theme it would be a negative response, if three agreed the theme it would be a mixed response, if four agreed the theme it would be a positive response and if five agreed the theme it would be a very positive response. For the four Heads of Faculty/School, if one agreed it would be a negative response, if two agreed it would be a mixed response, if three agreed it would be a positive response and if four agreed it would be a very positive response. For the two professional association representatives, one agreed was a mixed response and both agreed was a positive/very positive response. Again, researcher discretion was used to assess the responses depending on the number of neutral responses and whether the responses were agreed or strongly agreed.

The negative responses/outliers were captured in a table (the same as Table 6.18) under the colour coded tables to ensure that all relevant data was available in the one document for the analysis. A narrative was then created from this list of negative responses to explain and bring them into the discussion on the analysis of these sub-questions.

Each sub-question was then considered separately in terms of its overall outcome and then analysed further by group type and engineering discipline. The frequency of occurrence and the theme explanation was set out in the overall outcome sentence(s). The group type analysis gave the number of positive responses to the sub-question per group type. For instance, four Heads of Department strongly agreed this theme. A narrative summary for the management group, professional body representatives and academic staff was provided at the end of the group type analysis.

The engineering discipline analysis followed a similar format but the narrative summary included the number of civil engineers who agreed the theme versus the number of mechanical/electrical engineers who agreed the theme. In addition, the number of Heads of Faculty/Department versus the number of academic staff who agreed the theme was mentioned. Any other trend was also noted.

Table 6.19 and Table 6.20 provide the overall analysis for question three by group type and engineering discipline. Table 6.21 gives the narrative for the question three negative responses. Table 6.22 and Table 6.23 are the narrative summaries for sub-question 3(a). The narrative summaries by question for 3(b) and 3(c) and a small selection of the round two questions/sub-questions are available in Appendix U of this thesis.

Sub-Questions	A & SA	N A/D	D & SD	Overall Impression	Reg	PA Reps	HoF	HoD	Staff	Man
	%	%	%							
3a	58.33	12.50	29.17							
3b	50.00	20.83	29.17							
3c	75.00	8.33	16.67							

Table 6.19: Question Three Narrative Summary by Group Type

Sub-Questions	M & E	M & E	M & E	Civil	Civil	Civil
	HoF	HoD	Staff	HoF	HoD	Staff
3a						
3b						
3c						

Table 6.20: Question Three Narrative Summary by Engineering Discipline

M & E = mechanical/electrical engineering. *Civil = built environment/civil engineering.*

Four of the seven participants who did not agree to the Engineers Ireland accreditation remaining voluntary are academic staff (mostly civil engineers). The participants who did not agree with the concept that mandatory accreditation removes confusion were from all group types with more mechanical/electrical engineers than civil engineers. The four participants who disagreed that the combined process would make accreditation mandatory were not academic staff nor professional association representatives.

Table 6.21: Question Three Narrative on the Negative Responses

Registrars	Very Positive	5 of 6 Registrars agreed or strongly agreed
Prof. Association Reps.	Mixed	1 of 2 Prof. Association Reps. agreed/strongly agreed
Heads of Faculty	Very Positive	3 of 4 Heads of Faculty agreed or strongly agreed
Heads of Department	Mixed	3 of 6 Heads of Department agreed or strongly agreed
Academic Staff	Negative	2 of 6 academic staff agreed or strongly agreed
Management	Positive	11 of 16 management agreed or strongly agreed
		The management, particularly the Registrars and Heads of Faculty agreed that the accreditation process should remain voluntary. One of the Professional Association Representatives are also supportive of this view. Academic staff were fully supportive or fully against this theme.

Table 6.22: Sub-Question 3(a) Group Type Narrative

M & E Heads of Faculty	Mixed	1 of 2 Heads of Faculty agreed and 1 disagreed
M & E Heads of Department	Positive	2 of 3 Heads of Department agreed or strongly agreed and 1 selected the neutral option
M & E Academic Staff	Positive	2 of 3 academic staff strongly agreed and 1 disagreed
Civil Heads of Faculty	Positive	Both Heads of Faculty agreed or strongly agreed
Civil Heads of Department	Mixed	1 of 3 Heads of Department agreed, 1 disagreed and 1 selected the neutral option
Civil Academic Staff	Very Negative	3 of 3 academic staff disagreed or strongly disagreed
		Five of the eight mechanical/electrical engineers agreed or strongly agreed that the Engineers Ireland accreditation process should be voluntary. Three of the eight civil engineers agreed or strongly agreed. All the civil engineering academic staff disagreed or strongly disagreed with this theme (two strongly disagreed). Six of the ten Heads of Faculty/Department agreed or strongly agreed with two disagreeing and two selecting the neutral option. Two academic staff strongly agreed, two strongly disagreed and two disagreed.

Table 6.23: Sub-Question 3(a) Engineering Discipline Narrative

6.4.2 Narrative Summaries by Theme

The research outcomes from round two were established in the narrative summaries for each individual question and these were collected into a two-dimensional table showing the question number, emergent theme(s)/sub-questions, incidence of agreement of the theme among the research participants and narrative summary broken down by group type and engineering discipline, where applicable. Table 6.24 illustrates the question three portion of this narrative summary by theme. The complete overall narrative summary document for round two is given in Appendix U of this thesis.

Q	Sub-Question /Theme	Incidence (%)	Narrative Summary
3	3a	58.33	Fourteen of the twenty-four round two participants agreed that the seeking of Engineers Ireland accreditation for engineering programmes should remain voluntary. Members of each group type supported this theme but seven participants (1 Registrar, 1 Head of Faculty, 1 Head of Department and 4 staff) disagreed or strongly disagreed. Three participants selected the neutral option. More mechanical/electrical engineers supported this theme than civil engineers. All the civil engineering staff members disagreed or strongly disagreed with this theme.
3	3b	50.00	Twelve of the twenty-four participants agreed of strongly agreed that a mandatory Engineers Ireland accreditation process would remove confusion as to which engineering programmes are accredited by Engineers Ireland. Members of all group types supported and opposed this theme. Seven participants (2 Registrars, 1 Professional Association Representative, 1 Head of Faculty, 1 Head of Department and 2 staff) disagreed or strongly disagreed and five participants selected the neutral option. Only one registrar strongly disagreed. Civil engineers were very supportive but the mechanical/electrical engineers were mainly opposed to this theme.
3	3c	75.00	Eighteen of the twenty-four participants agreed or strongly agreed that combining the two processes into a single process would make the accreditation process mandatory. Members of all group types supported this theme but four participants (1 Registrar, 1 Head of Faculty and 2 Heads of Department) opposed it. Two participants selected the neutral option. Only one Head of Department strongly disagreed with this theme. There is a reasonably even distribution of responses across the engineering disciplines.

Table 6.24: Question Three Portion of The Round Two Overall Narrative Summary Document

6.5 Research Outcomes from Round Two

6.5.1 Determining Consensus

The Delphi technique is designed as a group communication process which aims to achieve a convergence of opinion on a specific real-world issue. The approach to measuring consensus is the least developed component of the Delphi technique and it varies from study to study (Crisp, et al., 1997). There is no single definition of consensus and it is up to the researcher to make a definition and give a rationale. There are a number of factors that may affect the definition used. For example, a study that assesses simultaneous agreement across multiple panels (professionals, consumers and caregivers) may have a lower cut-off for consensus than a study which involves a single expert panel. Similarly, the definition of consensus might be tighter for a study that aims to determine a small number of key statements of agreement than for one that aims to arrive at comprehensive and detailed guidance (Jorm, 2015).

The major statistics used in Delphi studies are measures of central tendency (means, median and mode) and level of dispersion (standard deviation and interquartile range). Generally, the uses of median score are favoured. In the literature, the use of median score, based on a Likert-type scale, is strongly favoured to reflect the convergence of opinions (Hsu & Sandford, 2007). Median is the number that is halfway in the dataset.

Frequency distributions are often used to assess agreement, and the criterion of at least 51% responding to any given response category is used to determine consensus (McKenna, 1994). In one study using yes-no response categories, the criterion for agreement was 67% of the participants giving the same response (Alexandrov, et al., 1996).

Some researchers use interquartile deviation (IQD) to determine consensus. The interquartile range is the absolute value of the difference between the 75th and 25th percentiles, with similar values indicating higher degrees of consensus (Rayens & Hahn, 2000). The interquartile range (IQR) depicts the extent to which the values of a given dataset are spread out from the mean. The interquartile deviation, also known as the semi-interquartile range, is used to measure spread or distribution of data (Wall Street Mojo, 2020). Raskin (1994) identified an IQD of 1.0 or less as an indicator of consensus. The potential range of IQD values depends on the number of response choices with larger IQDs expected as the number of response choices increases.

Some examples from the literature of how consensus has been defined is as follows:

- A study to develop guidelines for caregivers of people with bipolar disorder had separate expert panels of clinicians, caregivers and consumers, and required that each item had to have at least 80% endorsement as ‘essential’ or ‘important’ by each of the panels (Berk, et al., 2011);
- A study to develop mental health first aid guidelines for indigenous Australians required that an item had to have at least 90% endorsement as ‘essential’ or ‘important’ by a panel of indigenous mental health experts (Hart, et al., 2009);
- A study to develop post-disaster psychosocial care guidelines asked a mixed group of panellists to rate items on a nine-point scale from ‘completely disagree’ to ‘completely agree’ and required that an item had to have a mean score of greater than seven and 70% of panel members scoring seven or above (Bisson, et al., 2010).

Vogel, et al. (2019) defined consensus as greater than 70% of participants agreeing or strongly agreeing with a statement in rounds two or three. This level of agreement has been considered appropriate in previous Delphi studies (Slade, et al., 2014), (Henderson & Rubin, 2012) and (Diamond, et al., 2014). Slade, et al. (2014), advocated that at least 70% of the panel agree for consensus to be reached. Henderson & Rubin (2012) proposed a two-step process where the mean and standard deviation was estimated in step one and the presence of outliers were noted in step two. Diamond, et al. (2014) argued that the most common definition for consensus was percent agreement with 75% being the median threshold to define consensus. For most studies, all neutral or ‘don’t know’ responses were excluded from the group response to ensure that the reported percentage agreement or disagreement for each item represented the consensus among only those who made a response (Vogel, et al., 2019).

Percentages, medians and interquartile deviation are commonly calculated to determine consensus. Round two of this research study involves multi-level participants and a five-point Likert scale, which from the research literature would suggest 80% participant agreement to achieve consensus. This was therefore the level of agreement on themes in the present study (when the neutral responses were removed) that was chosen to indicate consensus. For each of the eighty-three sub-questions, the interquartile deviation and the median response were also estimated to confirm that consensus had been reached. Table 6.25 gives a sample of the consensus determination table and the full table is given in Appendix V.

Sub-Q	Interquartile Deviation	Median Response	A & SA % - with Neutral Data	A & SA % - without Neutral Data	Consensus
3a	1.38	Agree	58.33	66.67	No
3b	1.50	Neutral	50.00	63.16	No
3c	0.87	Agree	75.00	81.82	Yes
4a	0.50	Agree	91.66	95.65	Yes
4b	0.50	Agree	87.50	100.00	Yes
4c	0.50	Strongly Agree	91.66	100.00	Yes
5a	0.50	Agree	95.86	100.00	Yes
5b	0.50	Strongly Agree	83.33	86.96	Yes
5c	0.50	Agree	62.50	75.00	No
5d	0.50	Agree	62.50	78.95	No
5e	0.38	Agree	75.00	94.74	Yes
6a	0.50	Agree	91.66	100.00	Yes
6b	0.50	Strongly Agree	87.50	100.00	Yes
7a	0.50	Agree	70.83	85.00	Yes
7b	0.50	Agree	91.66	95.65	Yes
7c	0.87	Agree	75.00	94.74	Yes
7d	0.87	Agree	75.00	85.71	Yes
8a	0.50	Agree	83.33	95.24	Yes
8b	0.50	Agree	87.50	100.00	Yes
8c	0.50	Strongly Agree	91.66	95.65	Yes
8d	1.00	Agree	58.33	66.67	No
8e	0.00	Agree	87.50	100.00	Yes

Table 6.25: Sample of Round Two Consensus Determination

A = Agree response *SA = Strongly agree response*

Consensus was reached for most of the sub-questions, as shown in Table 6.25. To be considered to have reached consensus, each sub-question had an interquartile deviation of 1.0 or less, had a median response of agree or strongly agree and a percentage for the combined responses of agree and strongly agree of 80% or more when the neutral data was omitted from the calculations. All three-criteria had to be met. The sub-questions where consensus was not reached were further considered in round three of this study.

6.5.2 Creation of the Research Outcomes Document for Controlled Feedback to Participants

The overarching round two outcomes for the research were determined from the completed analysis (the narrative summaries) and consensus determination results. These overarching outcomes were the means of providing controlled feedback to participants at the commencement of round three of the research. Participants could view the overall responses of the other participants, through controlled feedback, and could gauge their response in light of this information.

Each of the seventeen themes and eighty-three items of the questionnaire was examined to ascertain the level of agreement amongst the research participants. The responses could be categorised into themes that gained general agreement (consensus was reached), and themes which garnered a wide variety of participant responses (unresolved issues), where consensus was not reached.

Each theme and its sub-questions were placed in a two -dimensional table and categorised into issues where there was general agreement and where there were still some issues to be further discussed with participants. A sample of the round two outcomes table showing question three (which had a higher percentage of unresolved issues than most themes) is given in Table 6.26. The full document is given in Appendix K of this thesis.

General Agreement	Unresolved Issues
	The Engineers Ireland accreditation process should remain voluntary (not imposed).
	A mandatory Engineers Ireland accreditation process would remove confusion as to which programmes are accredited by Engineers Ireland.
Combining the processes into a single process would make the Engineers Ireland accreditation process mandatory.	

Table 6.26: Question Three Portion of the Round Two Outcomes Document

6.6 Conclusion and Link to the Research Objectives

The research findings for this study are spread across three chapters of this thesis to reflect the three phases of data collection. Each phase of the data collection represents discrete elements for analysis and must be complete before the data collection can move to the next phase. The second round, discussed in this chapter, was a questionnaire.

The seventeen theme questions and the eighty-three sub-questions of the questionnaire were analysed individually by question. For each sub-question, the percentage of positive, negative and neutral responses were estimated. A conclusion in terms of positive responses was given for each question. The majority of questions elicited positive responses from the participants with a few questions having a wide variety of views. The full range of participant's responses were collated by participant to set up the data for the next level of analysis. A participant selections frequency analysis highlighted the agreement of the participant responses to the questions and correlates well with the round one outcome. An analysis of the 'neither agree nor disagree' participant responses allowed sub-questions to be identified that may have caused confusion and which may need to be clarified in round three.

In this chapter, question three was selected to demonstrate how the analysis was carried out for one question as there were a variety of participants' perspectives on mandatory or voluntary Engineers Ireland accreditation from round one and again in this round.

The analysis by theme considered the positive, negative and neutral responses per sub-question and an overall conclusion was prepared per theme. Preferences by group type and engineering discipline were determined. The use of colour coded systems allowed easier identification of these preferences. Further analysis by full-groups, sub-groups, management versus staff and within engineering disciplines ensued.

The overall questionnaire outcomes for the 1992 participant responses was as follows:

- 75% expressed agreement with the themes/sub-questions;
- 11% expressed disagreement with the themes/sub-questions;
- 14% were unsure and selected the 'neither agree nor disagree' option.

To complete the analysis, all the elements of the analysis were gathered together into narrative summaries by individual questions and an overall narrative summary across all the questions. The narrative summaries made it possible to examine each theme by participant group type and engineering discipline.

The themes were placed into those which had generally achieved consensus amongst the participants and those which generated a range of participant responses. Consensus was determined by interquartile deviation, median and participant agreement indicators.

Nine research objectives were outlined in chapter one of this research thesis to address the overall research question. The research objectives can be compared with the seventeen themes of the round two questionnaire. Table 6.27 provides a summary of the link between the research objectives and the round two research theme indicating where consensus was reached. When some sub-questions within a theme reached consensus and other sub-questions did not reach consensus, a partial consensus was noted for the theme.

Round Two Theme	Research Objective Number	Participant Consensus Reached
Quality assurance process overview	1, 3, 9	Yes
Mandatory or voluntary Engineers Ireland accreditation	3, 5, 9	Partial
Prospective and retrospective focus	3	Yes
Quality assurance review cycles	6, 8	Partial
Process similarities and their effect on workload	3, 6	Yes
Validation and accreditation objectives	1, 7, 9	Yes
Programmes not accredited by Engineers Ireland	3	Partial
Panel membership	3, 4, 8	Yes
Revised process – align or combine?	1, 4, 9	Partial
Revised process – independence of the outcomes – validation and accreditation	3, 9	Partial
Advantages to aligning / combining the two processes	2, 9	Yes
Disadvantages to aligning / combining the two processes	2, 9	Partial
Barriers to aligning / combining the two processes	2, 9	Partial
Method of alignment / combination of the two processes	1, 4, 9	Partial
Revised process - agenda	3, 6, 8	Yes
Responsibilities of the stakeholders in the revised process	1, 3, 7, 8, 9	Yes
Revised process – communication management	1, 3, 8, 9	Partial

Table 6.27: Link Between the Round Two Themes, Research Objectives and Participant Consensus

Chapter seven will provide the research findings and analysis for the Delphi round three interviews.

Chapter 7: Delphi Technique Round Three Interview Analysis

7.1 Overview

Chapters five, six and seven provide the research findings for this study. This chapter presents the research findings for the Delphi technique round three interviews. The analysis followed a similar approach to the first two Delphi rounds which was by question and then theme. Further breakdown by group type and engineering discipline ensued but is only an indicator of trend as the number of research participants in each category was small.

The Delphi round three interviews focused on issues where there was substantial variation in participant responses from the previous round. The content of this Delphi technique round three interview analysis is organised into five streams and follows the interview analysis by question, the interview analysis by theme including the analysis by group type and engineering discipline, the narrative summaries by question and theme, the identification of the themes which had achieved consensus by the end of round three and the themes which had divergent participant views and concludes with a summary of the outcomes from round three linked to the research objectives. Analysis within a stream involved a number of stages, in most instances.

The process involved in the analysis by question is described in stream two together with samples of the analysis. The research findings of the analysis by individual question is also provided. Stream three follows the same approach for the analysis by theme and provides in-depth analysis by group type and engineering discipline. Stream three also discusses the emergent themes for round three and links them to the research participants. The support for each theme is explored together with the frequency of occurrence of the theme. Responses outside of these themes are also examined in this stream. The approach to the generation of the narrative summaries by question and theme is set out in stream four together with samples of this analysis. Stream five discusses how the researcher determined when consensus was reached for each question. The chapter concludes with a summary of the themes that had achieved consensus from the Delphi technique rounds two and three analyses. A summary link between the research objectives and the round three analysis outcomes is provided. Further discussion on the research objectives is provided in chapter eight of this thesis.

7.2 Round Three Analysis by Question

7.2.1 Analysis by Individual Question

The round three interviews were captured on a tape-recording device and on question response notes. These question response notes were completed, on an individual participant basis, as the interview was underway. The notes were then checked against the recorded data and reorganised on a question by question basis to prepare the information for analysis. Each question was described in the title of the two-dimensional table and the participant's code and response was added underneath. The reorganisation of the data in this way made it possible to see at a glance the general response to each question and enabled the researcher to become familiar with this data.

There are thirteen round three questions. There is an opening question asking the participant's name, which was not included in the analysis. Therefore, there were twelve questions to be analysed per participant. The round three interview questions are as set out in Table 4.14, reproduced here for convenience.

Twenty-three of the twenty-four round two participants agreed to be interviewed in round three (response rate equates to 96%), as one of the round two participants (mechanical/electrical engineering academic staff member) could not be contacted. As a consequence, there were twenty-three interview participants and twelve questions which equates to 276 interview responses to be analysed.

The analysis by individual question had two main stages which occurred sequentially as follows:

- Comparison of participants' responses within individual questions;
- Creation of a list of emergent themes and comparison of participants' responses across all questions.

Table 7.1 gives the responses from participants to question two, round three (the Engineers Ireland accreditation process is voluntary at present. In a revised process, should it remain voluntary?). This question will be used as the example in all the streams of this chapter so that the reader can follow the analysis through the various stages. For consistency, this question has also been used as the example in rounds one and two. The participant responses for a selection of the twelve questions is given in Appendix W of this thesis.

Question Number	Round Three - Questions
1	What is your name?
2	The Engineers Ireland accreditation process is voluntary at present. In a revised process, should it remain voluntary?
3	Should a review cycle of five or six years be specified for the revised process?
4 4a 4b 4c 4d 4e 4f 4g	Based on the research outcomes to date and discussions with stakeholders and gatekeepers, I am putting forward a revised quality assurance model where the programmatic review process is adapted to combine with the Engineers Ireland accreditation process. Is it practical to include the programmatic review unique parts into the Engineers Ireland accreditation process and how can it be achieved? Should the entire evidence review be part of this revised process? Is it practical to have two independent process outcomes (validation and accreditation) from this combined process? Should one collaborative report or two separate reports for the processes be produced? Is it appropriate that the duration of the site visit be extended to include all the parts of both processes? Is it practical to have one set of documentation that captures the relevant information needed for the combined processes? Should this combined process be the template for interactions with other professional associations and why?
5	There are many other ways to align/combined the two processes. Would another method of alignment/combination be more appropriate and why?
6	Should non-standard entry to programmes affect their ability to be accredited by Engineers Ireland?
7	Any other questions, concerns or comments?

4.14: Round Three Interview Questions

Participant Code	The Engineers Ireland Accreditation Process is Voluntary at Present. In a Revised Process, should it Remain Voluntary?
α	It is Engineers Ireland's process so academia should not dictate whether it is voluntary or mandatory. There is merit in combining/aligning the processes.
β	It should remain voluntary as the HEIs should decide whether to apply for accreditation.
δ	Yes.
ε	Not mandatory. I would be reluctant to impose mandatory processes and allow professional associations that much power. HEI's manage their own affairs. No other professional associations have mandatory accreditation.
ζ	Yes, it should be voluntary. HEI's should have the freedom to decide if they wish to accredit their programmes.
ρ	Yes, remain voluntary.
θ	It should be involuntary (mandatory) for pure engineering programmes.
ɟ	Yes.
κ	Engineers Ireland is responsible for awarding professional titles. It should be mandatory for programmes with the B.Eng. award title.
λ	Not mandatory. Cannot be imposed.
μ	Professional association accreditation – discretion whether to apply should remain with the HEIs. Remain voluntary – leave the flexibility to decide whether to apply for accreditation.
ν	Yes, remain voluntary.
ξ	Voluntary. Mandatory would set our programmes apart.
π	In a combined process it would be difficult to be voluntary. No benefit to being voluntary. Engineering programmes should aspire to be accredited.
η	Mandatory. Benchmark against standards for all engineering programmes.
σ	Yes, remain voluntary.
τ	It should remain voluntary. For most programmes, with the possible exception of those in the civil engineering space, it lacks the statutory framework to make it mandatory. I would also question the relevance of Engineers Ireland to all programmes run in the engineering faculty.
ϕ	Previously, most programmes were accredited by Engineers Ireland. Currently level 8 programmes are not accredited. It has to be voluntary.
χ	It should be compulsory for all engineering programmes which leads to Chartered Engineer and other professional titles.
ω	Depends on the discipline of engineering – core civil, mechanical and electrical should be mandatory. Discretion on computer science and software engineering. Ideally, mandatory.
ς	Involuntary/mandatory. All students and employers expecting accreditation.
϶	Depends – Yes for B.Eng. programmes, especially at level 8. Other programmes unsure.
ⴳ	Yes, remain voluntary. Not all programmes get Engineers Ireland accreditation.

Table 7.1: Participant Responses to Question Two on Mandatory or Voluntary Accreditation

7.2.2 Comparison Across Participants' Responses Within Individual Questions

Once the participant responses by question had been prepared, responses could be compared across the twenty-three participants. Within each question, the participants' opinions were gathered to determine how many of the participants held the same viewpoint. A two-dimensional table was prepared, showing the participant opinions and which participant provided which view. Similar views were gathered under the same section of the table. Generally, three or four views emerged as the most commonly held opinions in each question with a number of comments shared by just one or a few participants. Table 7.2 illustrates how this analysis was prepared for question two.

Participant Code	**Should the Engineers Ireland Accreditation Process Remain Voluntary?**
Ϫ,β,ε,ζ,ϯ,λ,μ, ν,ξ,ρ,σ,τ,ϕ	Remain voluntary – cannot be imposed.
θ,κ,χ,ω,ς,Ͽ	It should be mandatory for pure engineering programmes (B.Eng. awards).
β,ε,ζ,μ	HEIs to decide whether to apply for Engineers Ireland accreditation.
Ϫ,ξ,ϕ,τ	Mandatory would set our programmes apart.
ω,Ͽ	Discretion for computer engineering or software programmes.
α	It is Engineers Ireland's process so academia should not dictate whether it is voluntary or mandatory.
ε	Mandatory would allow professional associations too much power.
ε	No other professional association has mandatory accreditation.
π	In a combined process, it would be difficult for the accreditation process to remain voluntary.
κ	HEI have B. Eng. programmes that are not accredited by Engineers Ireland.
ς	All students and employers expect accreditation.
η	Mandatory would benchmark all engineering programmes against standards
τ	Lacks the statutory framework to make it mandatory

Table 7.2: Comparison Across Participants' Responses Within Individual Questions

7.2.3 Research Findings of the Round Three Analysis by Individual Question

When the participant views document was created, responses to each question were analysed to create a list of emergent themes and conduct a comparison of participants' responses across all questions. This analysis involved coding the responses into various categories. The frequency of participant responses for the various categories was determined in percentage terms across the twelve questions. The percentages are a reflection of the instances of occurrence of the response. All responses are captured even though they may have a singular occurrence.

The information generated from the analysis was captured in round three emergent theme tables. The emergent theme tables are provided for a selection of questions in Appendix X of this thesis. Table 7.3 shows the emergent theme table for question two.

Emergent Theme	Incidence of Occurrence (%)
Remain voluntary – should not be imposed	56*
Mandatory for pure engineering awards (B.Eng.)	26*
HEIs should decide whether to apply for Engineers Ireland accreditation	17
Mandatory would set engineering programmes apart	17
All other participant's views are as shown in Table 7.2	

Table 7.3: Round Three Question Two Emergent Theme Table **Denotes significant*

Participant's views of the quality assurance process review cycles were explored in question three. The researcher categorised the responses into four main themes. 79% of participants suggested that a five yearly process review cycle would be appropriate. 17% of participants selected a six yearly process review cycle. 21% of participants indicated that the review period of the programmatic review and accreditation processes should coincide every five years. 17% of participants believe that five years may be too long as industry moves very quickly in some branches of engineering (Information Technology) and a shorter review period may be necessary for these disciplines. On-going communication, commitment and collaboration is needed between HEIs, QQI and Engineers Ireland.

Participants were asked whether it is possible to include the unique parts of the programmatic review process into the Engineers Ireland accreditation process in question 4(a). 87% of participants agreed that it was possible with no participant suggesting that it was impossible. 21% of participants argued that an integration of both processes into a new process would be preferable although 13% of participants agreed that some imagination would be needed in the design of the combined process. There was some discussion on the nature of the datasets as the programmatic review process is prospective (forward looking) and the Engineers Ireland accreditation process is retrospective (backward looking).

Should the entire evidence review be part of the revised process was queried in question 4(b). 83% of participants agreed and just 4% (one participant) disagreed. Some of the participants were not familiar with the evidence review or were unsure whether it should be included in the new process in its entirety. 21% of participants stated that the evidence review is a fundamental part, and strength of, the Engineers Ireland accreditation process.

The practicality of having two independent process outcomes (validation and accreditation) was considered in question 4(c). Twenty-one participants (91%) agreed that it is possible and none of the participants disagreed. 26% of the participants claimed that validation or accreditation may not be awarded to a programme. 13% of participants purported that there should be one outcome for B.Eng. award programmes where the programme would receive validation and accreditation, or neither. 13% of participants concurred that a new process should be well designed with a robust approach to validation and accreditation.

Whether there should be one collaborative report or two separate reports was examined in question 4(d). There were opposing views to this question with 60% of participants agreeing on one report and 40% of participants suggesting two separate reports. For the single report scenario, 34% of participants argued that the report should be in two or three sections, clearly segregated, which would ensure consistency in conditions. For the two reports scenario, 30% of participants mentioned that the reports go in different directions, are based on different criteria and have different emphases.

The duration of the site visit should be extended to cater for both processes was explored in question 4(e). 87% of participants suggested that the duration of the site visit should be extended and none of the participants disagreed. 47% of the participants would like to limit the duration of the site visit to two days, 17% suggested a limit of two and a half days and 13% suggested a limit of three to four days.

The practicality of having one set of documents which could be used for both processes was asked in question 4(f). 96% of participants agreed that it could be achieved and one participant (4%) disagreed. 21% of participants indicated that careful planning of the new process is needed.

Whether the combined process could be the template for other professional associations was explored in question 4(g). 79% of participants agreed and 8% disagreed with 13% unsure as they were unfamiliar with other professional association needs. The participants who agreed suggested that the new process could be adapted to suit other professional association needs.

Other methods of combination/alignment of the processes was examined in question five. 39% agreed that the programmatic review process should be adapted to fit the accreditation process. 26% of participants disagreed and suggested that the Engineers Ireland accreditation process should be adapted to fit into the programmatic review process or an integration of both processes. 35 % of participants were unsure which would be the most suitable method. A continual audit with trained reviewers was mentioned.

Could non-standard student entry to programmes affect their ability to gain accreditation was queried in question six. 91% of participants confirmed it should not affect their ability to gain accreditation, no participant disagreed and 9% of participants were unsure. 47% of participants agreed that the student achievement of the relevant learning outcomes should be the only judgement. 43% of participants stated that the recognition of prior learning criteria should be a more directly relevant process.

Participants were asked to provide any comments or concerns in question seven. Fifteen of the research participants made a comment under this heading. Some of the comments included that there is an absolute rational and opportunity to have this conversation about aligning/combining these processes where there is a lot of potential and benefit for HEIs, staff and professional associations, but will be challenging to achieve. The processes serve more than two masters including Engineers Ireland, the IEA, QQI and other international drivers. For Engineers Ireland accreditation, the major unique items to be completed are that the programme outcomes are covered, evidence is explored and an independent report is written. However, the Engineers Ireland accreditation board can change their process at any time. One participant suggested that keeping the timelines the same for both processes would be critical. Another participant mentioned that the weakness of the Engineers Ireland accreditation process is the consistency of panel membership, their training and competency.

7.3 Round Three Analysis by Theme

7.3.1 Individual Question Analysis by Theme

The analysis by theme was carried out in three phases as follows:

- Individual question analysis by theme and noting any supporting comments and outliers. The percentage of instances was estimated. Significant instances (greater than 25%) were noted. This was completed under Section 7.2.3 of this chapter;
- Cross referencing the individual question themes across the eleven questions in round three and noting the revised percentage of instances in which each theme occurred.
- The emergence of the common themes across all the questions.

This analysis generated a lot of documentation, and identical to the analysis presented in chapter six, the researcher deemed greater than 25% of participants mentioning a particular theme as significant. All responses from the interviews were categorised under each theme, irrespective of its relevance to the question posed, so that no data was lost during the analysis. The themes were identified within questions, but most themes appeared in other questions.

7.3.2 Cross Referencing of Individual Question Themes Across all Questions

The themes identified on an individual question basis were then sought across the responses from the twelve round three questions. For round one there was considerable overlap across questions and the analysis by theme was a major undertaking. For round two, there was some overlap across questions but in round three, the overlap reduced considerably. Nevertheless, some overlap in themes did occur in round three. Table 7.4 gives the outcome of the cross referencing for question two. It was noted that two of the emergent themes were very similar, and were mentioned by the same participants, so they were merged into one theme.

Thematic Area	Participant Code	Participant Views Within the Theme	Instances (%)
Mandatory or voluntary accreditation	Ϫ,β,ε,ζ,ϯ,λ,μ,ν, ξ,ρ,σ,τ,ϕ	Accreditation should remain voluntary	56*
	θ,κ,χ,ω,ς,Ͽ	Mandatory accreditation for B.Eng. awards which should aspire to be accredited	26*
	β,ε,ζ,μ	HEIs to decide to apply for accreditation	17

Table 7.4: Question Two Emerging Themes Across all Questions ** Denotes Significant*

7.3.3 Round Three Common Themes Across Questions

All the emergent themes from round three were gathered into one document titled '*Common Themes Across Questions'*. Re-estimation of the instances of occurrence was undertaken when all the singular occurrences were examined and added to the relevant theme. Table 7.5 shows the portion of this document pertaining to questions two and three. The entire document is given in Appendix Y of this thesis.

Question	Common Themes Across Questions	Incidence (%)
2	Accreditation should remain voluntary	56
2	Accreditation should be mandatory for B.Eng. awards. Engineering programmes should aspire to be accredited	26
2	HEIs should decide whether or not they wish to apply for Engineers Ireland accreditation	17
3	A combined process review cycle of five years is appropriate	91
3	Five years would overlap with the programmatic review cycle	26
3	Annual reporting would be worthwhile as industry is moving quickly	30
3	On-going communication, commitment, discussion and collaboration between HEIs, QQI and Engineers Ireland is needed	26

Table 7.5: Round Three, A Sample of the Common Themes Across Questions Document

When the common themes were identified, this information was used to assist with finalising the outcomes of the research.

7.3.4 Analysis by Group Types and Engineering Discipline Area

Preferences by group type and engineering discipline were identified. For each theme area, the first phase was to utilise the colour coded system from round two to enable easy identification of the group types and engineering disciplines on a two-dimensional chart. The chart illustrates each participant's response to each common theme. Each group type was assigned a colour as per chapter six. Where there were different engineering disciplines within the group type, different hues of the colour were used on the chart. Table 7.6 shows the chart for questions two, three and four part (a). Appendix Z of this thesis gives a selection of the charts for the other theme areas.

Theme	**2a**	**2b**	**2c**	**3a**	**3b**	**3c**	**3d**	**4a**	**4b**	**4c**	**4d**	**4e**
Code												
α												
ϐ												
δ												
ε												
ζ												
ρ												
ϑ												
ϯ												
κ												
ν												
μ												
λ												
π												
ξ												
τ												
σ												
η												
φ												
ϫ												
э												
ς												
ω												
χ												

Table 7.6: Sample of the Round Three Analysis by Group Type and Engineering Discipline

= Registrars (Governance)
= Professional Association Representatives
= Head of Faculty/School - mechanical/electrical engineering
= Head of Faculty/School - built environment/civil engineering
= Head of Department - mechanical/electrical engineering
= Head of Department - built environment/civil engineering
= Academic Staff – mechanical/electrical engineering
= Academic Staff – built environment/civil engineering

Each of these charts were further analysed for the common themes in each question to compare and contrast between organisational level participant's responses and engineering discipline participant's responses. The sequence of analysis was as follows for each question:

- Overall impression per theme;
- Analysis by full groups – Registrars, Heads of Faculty, etc.;
- Analysis by sub-groups – Heads of Faculty split into the engineering disciplines, etc.;
- Management versus staff responses – Registrars, Heads of Faculty, Heads of Department and academic staff;
- Analysis by mechanical/electrical engineering discipline -relevant heads of faculty, heads of department and academic staff;
- Analysis by built environment/civil engineering discipline – relevant Heads of Faculty, Heads of Department and academic staff;
- Responses outside the common themes.

A different colour code was used to describe the participants' responses for this analysis as shown below and is the same as the Delphi round two analysis (chapter six). The analysis by sub-groups also provides the information on the analysis for the mechanical/electrical engineering discipline and the analysis for the built environment /civil engineering discipline.

	Very Positive
	Positive
	Mixed
	Negative
	Neutral

Table 7.7 to Table 7.10 provides the tabular comparison and contrast colour analysis for question two by group type and engineering discipline per common theme. Appendix Z of this thesis gives the tables for a selection of the other theme areas.

Theme	Overall Impression of Participant's Responses
2a	
2b	
2c	

Table 7.7: Question Two Overall Impression of Participant's Responses per Common Theme

Theme	Registrars	Professional Associations	Heads of Faculty/School	Heads of Department	Academic Staff
2a					
2b					
2c					

Table 7.8: Question Two Analysis by Full Groups Per Common Theme

Theme	Heads of Faculty Mech & Elec	Heads of Department Mech & Elec	Academic Staff Mech & Elec	Heads of Faculty Built & Civil	Heads of Department Built & Civil	Academic Staff Built & Civil
2a						
2b						
2c						

Table 7.9: Question Two Analysis by Sub-groups and Engineering Discipline Division

Theme	Management (Heads of Faculty/Department)	Academic Staff
2a		
2b		
2c		

Table 7.10: Question Two Management Versus Staff Participant Responses

The overall impression for the first two common themes of question two is a positive participant response and the third theme has a mixed participant response. The Registrars and Heads of Faculty were most supportive of question two and the Professional Association Representatives the least positive. The civil engineering management and staff gave more positive responses than the mechanical/electrical engineering management and staff. The mechanical/electrical Heads of Faculty were less supportive of this theme than the civil engineering Heads of Faculty. This concurs with the round two analysis. The management gave more positive responses than the academic staff to theme 2(a) and this reversed for theme 2(b). There were a lot of mixed and neutral views expressed by participants which implied that consensus on these themes was not reached.

7.4 Round Three Narrative Summaries

7.4.1 Narrative Summaries by Question

All the data from the various tables were next gathered into coherent documents. The creation of these narrative summary documents occurred in two steps:

- The creation of narrative summaries by question;
- The creation of a comprehensive overall narrative summary by common theme.

The colour coded system from the Delphi rounds one (chapter five) and two (chapter six) was utilised so that the data could be easily compared across the three Delphi technique rounds. The negative blue colours did not apply to the rounds one and three analysis but were very important for the round two analysis.

The common themes were colour coded as per the Delphi round two analysis into two-dimensional tables which also included the frequency of occurrence of the theme. For each question there is an overall indication of participant agreement with the theme, a table for group type and a table for engineering discipline. The colour coding was applied consistently across all the themes as indicated in the next two paragraphs.

For the six Registrars and six Heads of Department, if one or two mentioned the theme, it would be considered a mixed response. If three mentioned the theme it would be considered a positive response, and if four or more mentioned the theme it would be a very positive response. No mention by a group type was considered as a ‘no view expressed’ response.

For the five-academic staff, if one or two mentioned the theme it would be a mixed response, if three mentioned the theme it would be considered a positive response, and more than three mentioning the theme would be considered a very positive response. For the four Heads of Faculty/School, one mention would be considered a mixed response, two mentions would be considered a positive response, and three or four mentions would be considered a very positive response. For the two professional association representatives, one mention would be a mixed response and two mentions a very positive response.

The participants’ responses outside the common themes were captured in a list (similar to Table 7.2) under the colour coded tables to ensure that all relevant data was available in the one document for further interpretation. A narrative was created from this list of responses to explain and bring them into the discussion around these common themes.

Each common theme was considered separately in terms of its overall outcome and analysed by group type and engineering discipline. The frequency of occurrence and the theme explanation was set out in the overall outcome sentence(s). The group type analysis gave the number of responses to the theme per group type. For instance, four Heads of Faculty mentioned this theme. A narrative summary for the management group, professional association representatives and academic staff was provided at the end of the group type analysis.

The engineering discipline analysis followed a similar format but the narrative summary included the number of built environment/civil engineers who mentioned the theme versus the number of mechanical/electrical engineers who mentioned the theme. In addition, the number of Heads of Faculty/Department versus the number of academic staff who mentioned the theme was recorded. Any other trend was also noted.

Table 7.11 and Table 7.12 provide the overall analysis for question two by group type and engineering discipline. Table 7.13 gives the narrative for the question two responses outside the common themes. Table 7.14 and Table 7.15 are the narrative summaries for theme 2(a) which queries whether accreditation should remain voluntary. The narrative summaries by question for themes 2(b) and 2(c) and a small selection of the round three common themes are available in Appendix AA of this thesis.

Theme	Incidence of Occurrence	Overall Impression	Regist.	Prof. Assoc. Reps.	Head Of Faculty	Head Of Dept.	Academic Staff	Managem.
	%							
2a	56							
2b	26							
2c	17							

Table 7.11: Question Two Narrative Summary by Group Type

- Very positive perspective
- Positive perspective
- Mixed perspectives
- No perspective expressed

	M & E	M & E	M & E	Civil	Civil	Civil
Theme	**HoF**	**HoD**	**Staff**	**HoF**	**HoD**	**Staff**
2a						
2b						
2c						

Table 7.12: Question Two Narrative Summary by Engineering Discipline

M & E = mechanical/electrical engineering. *Civil = civil engineering/built environment.*

HoF = Head of Faculty. *HoD = Head of Department.*

There is no statutory framework which would allow for mandatory accreditation of engineering programmes at present. Students and employers however expect engineering programmes to be accredited by the relevant professional association. So, in essence, the accreditation of engineering programmes becomes quasi-mandatory.
There is concern that mandatory accreditation would allow professional associations too much power within the higher education sector and that education providers would be subservient to professional associations.
Mandatory accreditation would allow programmes to be benchmarked against national and international standards.
There are some programmes that are regarded as engineering programmes but they do not readily fit the mathematics standards expected of engineers such as computer science and software engineering. Discretion would need to be exercised for these programmes.
There is a view that all engineering programmes should aspire to be accredited.
For this research, an aligned process would allow for accreditation to be voluntary but a combined process may cause accreditation to become de facto mandatory.

Table 7.13: Question Two Narrative on the Responses Outside the Common Themes

Registrars	Positive	3 of 6 Registrars mentioned the theme
Prof. Association Reps.	Mixed	1 of 2 Prof. Association Reps. mentioned the theme
Heads of Faculty	Very Positive	3 of 4 Heads of Faculty mentioned the theme
Heads of Department	Very Positive	4 of 6 Heads of Department mentioned the theme
Academic Staff	Mixed	1 of 5 academic staff mentioned the theme
Management	Very Positive	10 of 16 management mentioned the theme
		The management would like the accreditation process to remain voluntary. One of the Professional Association Representatives are also supportive of this view. Academic staff were less supportive of this theme. These outcomes are very similar to the round two outcomes for this theme.

Table 7.14: Common Theme 2(a) Group Type Narrative

M & E Heads of Faculty	Mixed	1 of 2 Heads of Faculty mentioned the theme
M & E Heads of Department	Positive	2 of 3 Heads of Department mentioned the theme
M & E Academic Staff	Mixed	1 of 2 academic staff mentioned the theme
Civil Heads of Faculty	Very Positive	Both Heads of Faculty mentioned the theme
Civil Heads of Department	Positive	2 of 3 Heads of Department mentioned the theme
Civil Academic Staff	No View Expressed	None of 3 academic staff mentioned the theme
		Four of the seven mechanical/electrical engineers mentioned that the Engineers Ireland accreditation process should be voluntary. Four of the eight civil engineers mentioned the theme. If the civil engineering academic staff are removed, then four of the five civil engineering managers mentioned the theme. Seven of the ten Heads of Faculty/Department mentioned the theme which is a high percentage. Only one academic staff member mentioned this theme. These outcomes are slightly more positive than the round two outcomes for this theme.

Table 7.15: Common Theme 2(a) Engineering Discipline Narrative

7.4.2 Narrative Summaries by Theme

The research outcomes from round three were established in the narrative summaries for each individual question and these were collected together into a two-dimensional table showing the question number, common theme, frequency of occurrence of the theme among the research participants and the overall outcomes of the common theme together with the group type and engineering discipline overall narratives, where applicable. Table 7.16 illustrates the question two portion of this narrative summary by theme. The complete narrative summary by theme document for round three is given in Appendix AA of this thesis.

Q	Theme	Incidence (%)	Narrative Summary
2	2(a)	56	There is strong agreement that the seeking of accreditation for engineering programmes should remain voluntary. In particular, the Registrars, Heads of Faculty and Heads of Department expressed this view. It is less of a concern for academic staff. This theme was positively supported by all the engineering disciplines.
2	2(b)	26	Six of the participants mentioned that accreditation should be mandatory for programmes with B.Eng. awards. Academic staff are strongly in favour of this theme but only one in sixteen management staff mentions it. There is a reasonably even distribution of support for this theme across the engineering disciplines.
2	2(c)	17	Four of the participants mentioned that it is the HEI's decision whether to apply for Engineers Ireland accreditation. This theme is not mentioned by Heads of Department, Academic Staff or the Professional Body Representatives but resonated only at Registrar and Head of Faculty level (one civil engineer).

Table 7.16: Question Two Portion of the Round Three Narrative Summary by Theme Document

Management and academic staff seem to have different priorities where management seem to be more accountable for the programmatic review process but academics are more aligned with their discipline and thus with professional accreditation.

7.5 Outcomes from Round Three

7.5.1 Determining Consensus

Percentages, medians and interquartile deviation are commonly calculated to determine consensus. Round three of this research study involved interviews with multi-level participants. Based on the Delphi literature, a threshold of themes with 80% participant agreement (when the neutral data was removed) was considered to indicate consensus from the research participants. The interquartile deviation and median response could not be reliably calculated for this interview data.

The researcher estimated the percentage of positive responses to the specific question asked, and excluded any unsure responses (neutral data) to confirm whether consensus had been reached. Any other common themes which emerged from the interview data will be considered in chapter eight but did not form part of this analysis. Table 7.17 gives the consensus determination information for round three.

Question	Response	Response	Consensus
	% - with Neutral Data	% - without Neutral Data	
1	n/a	n/a	n/a
2	56.0	56.0	***No***
3	91.0	91.0	Yes
4a	87.0	87.0	Yes
4b	83.0	95.4	Yes
4c	91.0	100.0	Yes
4d	60.0	60.0	***No***
4e	87.0	100.0	Yes
4f	96.0	96.0	Yes
4g	79.0	90.8	Yes
5	39.0	60.0	***No***
6	91.0	100.0	Yes
7	n/a	n/a	n/a

Table 7.17: Round Three Consensus Determination *n/a = not applicable*

Consensus was reached for most of the questions, as shown in Table 7.17. To be considered to have reached consensus, each question had a positive percentage response of 80% or more when the neutral data (unsure responses) was omitted from the calculations.

The three questions where consensus was not reached are:

- Should the Engineers Ireland accreditation process remain voluntary;
- Should there be one collaborative report or two separate reports;
- The most appropriate method of alignment/combination of the processes.

The research participants seem to find the voluntary or mandatory accreditation question difficult to answer as they could put forward a rationale for both scenarios. In round one, 69% of participants suggested that the accreditation process should be voluntary. This reduced to 58.33% in round two and 56% in round three. Even though the majority of participants agreed that the process should remain voluntary, there was no convergence to voluntary or mandatory accreditation. Further rounds of the Delphi technique would be unlikely to achieve consensus on this topic.

The question of one or two reports for accreditation and programmatic review emerged from the round one interviews, and was asked in the round two questionnaire and again in round three. In round two, 58.33% of participants agreed that two separate reports could be produced for the aligned scenario, and 75% of participants agreed that one collaborative report could be created for the combined scenario. In round three, 60% of participants suggested one report for the combined scenario and 40% of participants agreed two separate reports for the aligned scenario. As there is no agreement on which scenario should apply when bringing the processes into closer alignment, and based on the percentage responses, further rounds of the Delphi technique would be unlikely to achieve consensus on this matter.

The most appropriate method of combination or alignment of the processes has elicited a variety of responses from participants. In round one, 92% of participants agreed that both processes could be combined into a single quality assurance process but differed on how this could be achieved. 46% of the participants in round one suggested that the accreditation process should fit into the programmatic review process. In round two, 70.83% of participants suggested the accreditation process should fit into the programmatic review process, 37.50% agreed that it should be the opposite way around and 66.67% of participant suggested the both processes be integrated into a single process. In round three, just 26% of participants suggested that the accreditation process should fit into the programmatic review process, 39% suggested the programmatic review should fit into the accreditation process and 35% were unsure how it could be achieved. Further rounds of the Delphi technique would be unlikely to achieve consensus on the method of combination/alignment of the processes.

7.5.2 Creation of the Round Three Research Outcomes Document

The overarching round three outcomes for the research were determined from the narrative summaries and consensus determination results. Each of the interview questions were examined to ascertain the level of agreement amongst the research participants. The round two research outcomes document (see Appendix K) was modified to move the agreed themes in round three from the unresolved issues column to the general agreement column of the document but three questions remained in the unresolved issues column. The round three research outcomes document is given in Appendix AB of this thesis.

7.6. Conclusion and Link to the Research Objectives

The research findings for this study are spread across three chapters of this thesis to reflect the three phases of data collection. Each phase of the data collection are discrete elements for analysis and must be complete before the data collection can move to the next phase. The final round was a semi-structured interview.

The round three analysis began with the analysis by individual question. The interview data was examined and reorganised on a question by question basis. Each participant's contribution to each question was noted and similar views were grouped together. Generally, four or five emerging themes were identified per question. Responses outside the emerging themes were noted to ensure that all the interview data was available for the analysis.

Question two was selected to demonstrate how the analysis was carried out for one question as there were a variety of participants' perspectives on mandatory or voluntary Engineers Ireland accreditation from rounds one and two. Similar divergence of participants' opinions occurred in round three for this question.

The analysis by theme resulted in a small number of common themes per question. The incidence of occurrence of the common themes were re-evaluated following this cross-referencing across the questions. Preferences by group type and engineering discipline were determined by using colour coded systems. Further analysis by full-groups, sub-groups, management versus staff and within engineering disciplines ensued. The researcher created narrative summaries by discrete questions and an overall narrative summary across all the questions. The narrative summaries allowed each common theme to be explored by participant group type and engineering discipline.

Questions where consensus was, or was not, achieved, were identified based on 80% participant agreement. There were three questions where consensus was not reached in round three. Reviewing the participants' responses from rounds one, two and three for the three questions, highlighted that further rounds of the Delphi technique were unlikely to alter the participants' responses sufficiently to achieve consensus.

Nine research objectives were outlined in chapter one of this research thesis to address the overall research question. The research objectives were compared with the interview questions of round three. Table 7.18 provides a summary of the link between the research objectives, the round three questions and where consensus was reached. The research objectives will be further discussed in chapter eight of this thesis.

Round Three Questions	Research Objective Number	Participant Consensus
Accreditation should remain voluntary	1, 3, 5, 9	No
A review cycle of five or six years is appropriate	3, 6	Yes
It is practical to have the unique parts of the programmatic review process included in the accreditation process	1, 3, 4, 6, 7	Yes
The entire evidence review should be part of the revised process(es)	1, 3, 4, 7	Yes
Is it practical to have two independent process outcomes – validation and accreditation	3, 5, 7, 9	Yes
Should there be one collaborative report or two separate reports	3, 5, 7, 8, 9	No
Should the duration of the site visit be extended	4, 6	Yes
Is it practical to have one set of documentation for submission for the programmatic review and accreditation processes	2, 3, 8	Yes
Could the revised process(es) be the template for other professional association accreditations	1, 2, 3, 7	Yes
Which method of alignment / combination of the processes would be the most appropriate	1, 3, 4, 6, 7, 8, 9	No
Should non-standard entry to programmes affect their ability to be accredited by Engineers Ireland	2, 3	Yes

Table 7.18: Linking the Round Three Questions, Research Objectives and Participant Consensus

Chapter 8: Interpretation and Discussion of the Research Findings

8.1 Overview

Chapter eight provides the researcher’s interpretation and discussion of the research findings for this study. This chapter brings together the research findings from chapters five, six and seven and discusses their repercussions for the two major quality assurance processes of engineering education. Implications arising from the research, for the main stakeholders involved in these processes, are appraised.

The research findings were presented in three chapters to mirror the data collection phases of the Delphi technique. Twenty-six multi-level research participants (see Table 4.7) contributed to the research findings in round one, twenty-four in round two and twenty-three in round three. All three rounds were analysed in a different way, according to the nature of the data collection method, and the analysis results were assembled into narrative summaries and linked to the research objectives.

The content of this chapter is organised into five streams and follows the response to the research question and each of the nine research objectives based on the findings, identifying unexpected findings, explaining the limitations of this research study, exploring the implications of the research findings for the process stakeholders and concludes with a summary of the outcomes from the research. Deliberation within a stream involved a number of stages, in most instances.

The answers to the research question and objectives are debated in stream two with reference to the literature, evidenced based interpretation of the findings of this study, theory and effect on practice. The generalisability of the research findings is also considered in stream two. Stream three outlines the unexpected findings in the research. Stream four describes the limitations of the study, the importance of the limitations to the interpretation of the findings and their impact on validity and reliability of the data. Reflection on the ramifications of the research findings for engineering education programmes, higher education institutions, professional associations, policy makers, academic staff, students and the engineering profession are examined in stream five. The chapter concludes with a summary of the research outcomes and the implications for all involved in the programmatic review and Engineers Ireland accreditation processes.

8.2 Response to the Research Question and Objectives Based on the Research Findings

8.2.1 Research Question

The research question for this study is as follows:

How can the external accreditation process of engineering education programmes in Ireland be brought into closer alignment with the internal quality assurance programmatic review process of these programmes?

Based on the findings in chapters five, six and seven, the research participants have strongly agreed that the external accreditation process of engineering education programmes in Ireland can be brought into closer alignment with the internal programmatic review process in institutes of technology/technological universities. The participants expressed the views that this study is '*worthwhile research to assess the viability of combining/aligning the processes'* and '*there is strong merit in combining/aligning the processes'* but concurred that '*decision making, communication and responsibility are vital to the success of this study.*' It proved more challenging to get participant agreement on the methodology to achieve the combination/alignment of the processes.

Both quality assurance processes have evolved from humbler beginnings into substantial events and at the same time the importance of engineering education programme review and accreditation has also intensified. The length of preparation and implementation of the processes has increased with time. Many academic staff have expressed the view that engineering education programmes seem to be constantly under review. As the processes have become more complicated, the desire to converge them has become more urgent.

In engineering education quality assurance, there are two main powerbrokers, the state and the professional associations, acting as gatekeepers and controllers for admission to the engineering profession. Programmatic review and accreditation are policy driven processes where admission to a professional elite is controlled by adherence to the relevant policies and procedures. There are many stakeholders to these processes but the education providers (HEIs/QQI/HEA) and the professional associations (Engineers Ireland, SCSI, and others) are the primary stakeholders. It has emerged, from consultation with the relevant gatekeepers and stakeholders to the processes, that it is imperative to determine whether it is possible to merge the objectives and implementation methodology of these processes which would make the possibility of combining/aligning them more realistic and sustainable over time.

Questions about the most appropriate method of combination or alignment of the processes have elicited a variety of perspectives from participants. 92% of participants agree that both processes could be combined into a single quality assurance process but differ in how this could be achieved. 71% of participants suggest that the accreditation process could be embedded into the programmatic review process and 67% agree that the processes could be integrated into a single process.

Participants gave a variety of opinions on how the processes could be combined/aligned in the final round of data collection. Embedding the relevant parts of the programmatic review process into the accreditation process is mainly supported by the heads of department and registrars but is not supported by the professional body representatives, which is significant as they would then have to manage the programmatic review. The other methods of combination/alignment were supported by members of all group types. Combining both processes resonated more with the civil engineers than the mechanical/electrical engineers. The mechanical/electrical engineers are more in favour of the inclusion of the accreditation process into the programmatic review process than the civil engineers as they are generally less supportive of accrediting engineering programmes (See Tables 7.14 to 7.16, questions 10 and 15 of appendix U and question 5 of appendix AA).

Consensus was not achieved on the method of combination or alignment of the programmatic review and accreditation processes and this will be further examined in section 8.2.5 of this chapter.

8.2.2 Research Objective One: Willingness to Bring the Processes into Closer Alignment

Research objective one for this study is '*to probe the willingness of stakeholders to engage with the concept of bringing the quality assurance processes into closer alignment.*'

Eighty-eight percent of the participants agree or strongly agree that the programmatic review and Engineers Ireland accreditation processes are necessary parts of the engineering programme development cycle. 96% of participants confirmed that there was a positive improvement to engineering programmes as a result of these processes and 82% agree that their experience of both processes is positive. This is a strong endorsement that the quality assurance processes contribute positively to the quality of engineering education. The benefits are tangible for programmes, students and HEIs.

The value of programmatic review and accreditation is appreciated by the participants with 92% agreeing that the processes *'check the validity, currency and relevance of programmes'* and 96% agreeing that the processes support '*programmes to hold up internationally where student qualifications are recognised abroad*.' 92% of participants concur that the programmatic review process creates modifications to existing programmes, mostly on the technical side, where staff reflect on what is being delivered. In addition, the accreditation process causes reflection on soft skills and ethics and 88% of participants agree that it '*focuses on meeting standards and benchmarks engineering programmes to a level of professional competence.'* 88% of participants suggest that the programmatic review process has a broader view, is strategic direction focused and has a lot of overlap with the accreditation process which '*have similar objectives to produce capable engineers.*'

All but two of the participants agree or strongly agree that the processes could be combined into a single quality assurance process. The participants assert that '*closer alignment is most appropriate and needed'* and state that *'there is an absolute rationale to have this conversation, with lots of benefits to all stakeholders, but would be challenging to achieve.'* Some participants are of the view that *'there are advantages to combining them fully or partially, combining would achieve a significant resource saving for the HEI and that the compromise would be worth it if it achieves the goal.'* Other perspectives expressed by participants in support of this objective include:

- Transactions around evaluations causes fatigue for all involved;
- Engineers Ireland accreditation is most relevant for civil engineers and less so for mechanical and electrical engineers;
- The double approach where programmes seem to be constantly under review puts pressure on academics and managers and repetition is annoying for industry;
- There is a huge workload for staff which is cumbersome and involves repetition;
- Any reduction would have a positive impact on teaching and would gain staff and stakeholder buy-in if less frequent.

Participants recognise that the two processes have different outcomes and international influencers, there is no role for professional associations in the programmatic review process and there needs to be collaboration between HEIs, QQI and Engineers Ireland. Members of all group types and engineering disciplines supported these themes (See Tables 6.13 and 6.19 to 6.24, question 10 of appendix U and question 3 of appendix AA).

The Engineers Ireland Accreditation Review 2019 report observes that there is a '*strong desire to link/align the accreditation process in some way with the programmatic review process to reduce the administrative burden on HEIs and review panels*.' The report states that linking may not be possible for universities as reviews there are continuous and not subject to a five-yearly review cycle. The accreditation visit is considered very intensive for HEIs and panels. It acknowledges that '*accreditation and programmatic review serve different purposes and have a different set of programme outcomes and Engineers Ireland need to ensure compliance with international accords.*' It highlights that HEIs cannot afford the costs of overlapping and potentially conflicting quality assurance processes (Engineers Ireland, 2019). The sentiments in this report agrees with the findings of this research.

The PARN study, discussed in chapter 2, explores the opportunities for establishing closer working relationships between QQI/HEIs and the professional associations. The report states that the relationship between internal quality assurance and external accreditation runs from accreditation to programmatic review but for a significant number of professional associations there is no relationship between the processes. The report aligns with the research findings that the professional associations are focused more on professional competence whereas the HEIs are focused on faculties/departments as a whole and with standardising approaches across the HEI. The PARN report recommends that the relationship between the internal quality assurance process and the external accreditation would benefit from further research (PARN, 2017).

A Joint Statement of Principles for Professional Accreditation issued by Universities Australia and Professions Australia states that '*it is recognised that a complementary approach is necessary to harmonise the separate academic and professional accreditation processes and avoid duplication of effort*' (Universities Australia and Professions Australia, 2016). The findings of the present study are consistent with this statement, particularly around the concept of bringing the separate quality assurance processes into closer alignment. QQI are using this document as a guide to creating an Irish set of accreditation principles.

Murphy (2009) observes that it is the more articulate and powerful interests in society who stamp their own designs on the educational system and thus establish the context within which quality in education is to be understood and pursued. The range of professional associations with their own accreditation standards/criteria in the engineering/construction disciplines makes the accreditation process complex in faculties/schools of engineering.

The research participants consider that '*engineering/construction programmes can be accredited to more than one professional association and have at least two masters'* in the quality assurance domain. Extending a revised process to other professional associations may increase complexity as there will be mapping required to different standards as the process is adapted to suit the professional association criteria. Some professional associations have radically different accreditation criteria. Extending a revised process to other faculties or departments in institutes of technology/technological universities could have the same challenges of mapping to different criteria but the participants believe that '*the programmes (of other faculties) would benefit from an in-depth evidence review similar to that of Engineers Ireland*.'

Based on the research findings, it is clear that there is a willingness to bring the quality assurance processes into closer alignment with 83% of participants agreeing that '*there should be greater alignment between academic and professional education.'* The literature supports and agrees with this outcome as does the consensus reached by the research participants on this objective.

8.2.3 Research Objective Two: Advantages, Disadvantages and Barriers

Research objective two for this study is '*to identify and critically appraise the advantages, disadvantages and barriers to bringing the engineering education programmatic review and accreditation processes into closer alignment.'*

Ninety-six percent of the research participants identify '*savings in work, time, effort and documentation'* as the chief advantages to bringing the quality assurance processes into closer alignment. 92% percent of participants agree that '*reducing the quantity of review activity, examining programmes at the same point in time and not duplicating workload'* are also significant advantages. 88% of participants suggest that achieving combination or alignment of the processes would '*unlock time for staff to focus on other initiatives.'* There are many advantages to combining or aligning the processes fully or partially as '*there are a lot of commonalities*.' A small number of participants suggest that the advantages outweighed the disadvantages. Almost all participants expressed full agreement on the advantages to achieving the research objective.

All research participants recognise that there are disadvantages to combining/aligning the processes. 88% of participants agree that some programmes are '*accredited by two or more professional associations'* and some programmes are '*not accredited by any professional association'*. Accreditation is considered to be a very onerous exercise with '*issues at granular and large scale.'* 71% of participants expect that '*answering to two masters in the one process could require panel member guidance*.' 54% of participants are concerned that '*the evidence review could be scaled back'* to suit the programmatic review process. 58% of participants agree that '*the composition of the review panel'* would be difficult to implement and '*non-standard entry to programmes may limit accreditation.'* '*Fees for accreditation'* was mentioned by a few participants. Engineers Ireland accreditation varies for level eight programmes.

Ninety-two percent of participants affirm that there are barriers to combining/aligning the processes. 96% percent of participants agree that '*the processes have different objectives and a new process would need clear protocols, responsibilities defined and a framework at a high level.'* 92% of participants confirm that *'new programmes cannot be accredited until they have graduates*.' Neither the HEI or Engineers Ireland can cede responsibility to the other party and Engineers Ireland has statutory entitlement to have their own professional accreditation process. 83% of participants assert that '*Engineers Ireland accreditation is not appropriate for the full range of programmes in faculties/schools of engineering*.'

Other possible barriers mentioned by the research participants include:

- The strategic reflection needs to be maintained in a combined/aligned process;
- Review cycles may be out of phase;
- Interviews with graduates and employers are programme specific in the Engineers Ireland accreditation process.

The advantages, disadvantages and barriers were mentioned across all the Delphi rounds of the data collection. Significant percentages of participants support the advantages to bringing the processes into closer alignment. The Engineers Ireland Accreditation Review report identified similar advantages to those offered by the research participants and mentions that '*the processes are almost identical*' (Engineers Ireland, 2019). The Joint Statement of Principles for Professional Accreditation emphasises the '*avoidance of duplication of effort or process'* which was confirmed by the research findings (Universities Australia and Professions Australia, 2016).

The PARN report evaluates the benefits to HEIs applying for professional accreditation as contributing to maintaining high standards, keeping programmes current by allowing benchmarking to an international standard, peer review and consistency of review but it does not compare across the quality assurance processes. The report also notes that reputation and marketing of a programme improves if it is awarded accreditation. Students can become more employable and can achieve professional association titles with experience (PARN, 2017). The high-level advantages identified in this study confirm the benefits proposed in the PARN report.

The disadvantages and barriers to combining/aligning the processes could be read as one set of challenges. The following disadvantages and barriers will be discussed in other sections of this chapter:

- Accredited by two or more professional associations;
- Composition of the review panel;
- Non-standard entry to programmes;
- Validation and accreditation objectives;
- Review cycles;
- Interviews with graduates and employers are programme specific.

A proposal for how to align the processes will be outlined in section 8.2.5 and many of these challenges will be addressed there and in the remainder of this chapter.

The QQI Insights report identifies challenges professional associations encounter during the accreditation process which includes financing the accreditation process and finding panel members for site visits (QQI, 2019). The cost of Engineers Ireland accreditation is viewed by the research participants as very expensive but it is in keeping with the average costs mentioned in the PARN report. The PARN report suggests that the use of technology may assist with reducing accreditation costs. The QQI Insights report confirms that many professional associations absorb the costs of accreditation and there seems to be ambiguity around what price is appropriate to charge for the accreditation process (QQI, 2019).

Similar to the QQI Insights report, the Engineers Ireland Accreditation Review report states that '*difficulties are experienced in staffing accreditation panels*' (Engineers Ireland, 2019). These difficulties can lead to accreditation visits to HEIs being cancelled due to a difficulty finding appropriately experienced volunteers for a two-day process on specific dates.

The PARN report claims that a significant amount of time is spent on producing documentation, preparing for the site visit and undertaking self-evaluation. The report also identified other challenges of accreditation for HEIs as:

- Excessive and unnecessary time and resource requirements;
- Interruption to the academic cycle;
- The dual awards of accreditation and programmatic review is a duplication of resource;
- Slow application and approval procedures by the professional association;
- Lack of priority of this activity for academics;
- Poor understanding of educational standards by accrediting associations;
- Changing accreditation criteria;
- Working with multiple stakeholders.

Again, the challenges identified above are similar to the challenges identified in this research.

It is important to have staff buy-in as some staff regard these quality assurance processes as not their core function. However, the operational reality for academic department leaders can be challenging. Gardner (2014) warns that it is never easy to bring about a change of mind-set as the ranks of faculty are loaded with tenured individuals who have scant incentive to change their attitude or behaviours. To successfully manage the accreditation process, the head of faculty/department must balance the accreditation tasks, relations between programme boards and external demands (the accreditation panel). From the researcher’s experience, when the vision of accreditation and its benefits for programme graduates are communicated to faculty staff, and supported by a strong rationale, then there can be strong commitment from staff.

Identification of the advantages and disadvantages of combining programmatic review and accreditation were consistent throughout all rounds of the Delphi process and supported by all group types with an even distribution of responses across the engineering disciplines. Identification of the barriers to bringing the processes into closer alignment was supported by all group types but more so the mechanical/electrical engineers in round one. Feedback of the research outcomes through the questionnaire in round two resulted in an even distribution of responses to the barriers across the engineering disciplines (see questions 6, 7 and 9 of appendix O themes summary document and questions12, 13 and 14 of appendix U themes summary document).

Based on the research findings and the literature, it is clear that there are advantages, disadvantages and barriers to combining the processes but it is the view of participants that '*it is not beyond the wit of intelligent people to overcome the challenges.'* A high proportion of the participants have identified and reached consensus on these advantages, disadvantages and barriers.

8.2.4 Research Objective Three: Power, Responsibilities and Influence of Stakeholders

Research objective three for this study is *'to explore and appraise the power, responsibilities and influence of the main stakeholders to the quality assurance processes for engineering education.'*

For the programmatic review process, 92% of the research participants mentioned employers as a major stakeholder, 84% mentioned students, 77% mentioned staff, 69% mentioned the HEI, 38% mentioned the engineering profession, 27% mentioned QQI and 27% mentioned graduates. For the Engineers Ireland accreditation process, 80% of participants mentioned employers, 65% mentioned students, 65% mentioned staff, 65% mentioned Engineers Ireland, 58% mentioned the HEI, 54% mentioned the engineering profession and 30% mentioned graduates. The main stakeholders to these quality assurance processes are the same except for QQI and Engineers Ireland, which is not surprising as these are the respective stakeholders that are the gatekeepers of the two processes. A range of other stakeholders were mentioned as set out in section 5.2.3 of this thesis.

The primary stakeholders are the education providers and the professional associations. In bringing the quality assurance processes into closer alignment, questions of authority, power, responsibility and legality arise. Currently, there is no role for professional associations in the programmatic review process. 71% of the research participants suggest that neither the HEI, nor Engineers Ireland, can cede their role to another party. The participants expressed the opinion that *'neither registrar can give authority to the other registrar to validate or accredit a programme*.' The importance of agreeing a Memorandum of Understanding between HEIs, QQI and Engineers Ireland was emphasised by 83% of the research participants. The QQI Insights report recommends that professional associations should have the power to deny accreditation when appropriate, but this is rarely exercised by the professional associations (QQI, 2019).

From January 1st 2020, HEIs have become Designated Awarding Bodies under the auspices of QQI. Designated awarding bodies can grant awards from level 6 to level 9 on the NFQ. Also, under the Institute of Technology Act, relevant HEIs have statutory authority to grant awards. Each HEI has developed its own quality assurance framework and liaises with QQI annually on their quality assurance policies and procedures. On that basis, HEIs cannot cede their statutory authority or responsibility to another party. The participant group types concur with this view but more civil engineers agree with it than mechanical/electrical engineers.

Engineers Ireland is recognised by an Act of the Oireachtas as the sole licensee to award the title 'Chartered Engineer' within Ireland and to maintain a register of Chartered Engineers practising in Ireland (Cox & O'Dwyer, 2014). Engineers Ireland is the designated Competent Authority for the engineering profession in Ireland under the EU Directive on the Recognition of Professional Qualifications (European Parliament, 2013). Engineers Ireland has partnered with ENAEE and the content of their standards reflect the criteria required by ENAEE and three IEA international accords. Engineers Ireland is periodically assessed by international review teams to ensure that accreditations are performed to the ENAEE and IEA standards. On that basis, Engineers Ireland cannot cede its authority and responsibility to a third party and must demonstrate independence of the process to its international partners (QQI, 2019). The research participants' perspectives were consistent with that view and one participant stated that '*the evidence of this clarity of independence will need to be maintained.*'

Other professional associations in the engineering and construction sphere have international links. The SCSI standards for surveying programmes are based upon the standards of the Royal Institution of Chartered Surveyors with input from the SCSI Council. The RIAI standards are based on Article 46 of EU Directive 2013/55/EU. The RIAI is an active member of the Architects Council of Europe and the European Network of Competent Authorities (QQI, 2019). The issue of professional associations not ceding their authority and responsibility also holds true for the primary professional bodies in the engineering and construction disciplines. National quality assurance guidelines and education providers are bound by European standards and guidelines, and similarly, professional associations are bound by international agreements (PARN, 2017) The research participants agreed these views and added that '*it can be difficult to satisfy many masters when programmes are accredited to many professional associations*.'

Engineers Ireland has a major influence on the design of engineering programmes. 88% of participants confirm that responsibility for the programmatic review process lies with the HEI's academic council, managed through the registrar's office, and responsibility for the accreditation process lies with the Engineers Ireland accreditation board, managed by the Engineers Ireland's registrar's office. Participants note that programmatic review is similar, but not exactly the same, in all institutes of technology. 88% of participants agree that academic council approves the programmes on the HEI registrar and the Engineers Ireland accreditation board approves programmes for accreditation. 71% of participants suggest that '*there should be shared responsibility'* in the closer alignment scenario but 23% of participants caution that *'academic council and the accreditation board can only accept their own areas of responsibility and approvals*.' 88% of participants observe that an engineering programme may be validated to one NFQ level but accredited to one of three professional titles. 83% of participants agree that '*a Joint Overseeing Group' may be required for changes and decisions*.' One participant suggests that the HEI could take responsibility for accreditation as the HEI registrars need to consider all disciplines, not just engineering. All participant group types support these views but the mechanical/electrical engineers are less supportive of them than the civil engineers (See appendices O, U and AA).

In Australia, the members of Professions Australia work in partnership with the universities (Universities Australia) and the higher education sector through their accreditation activities. The Joint Statement of Principles for Professional Accreditation also expects that education providers and professional associations '*share and accept information from complementary accreditation processes'* (Universities Australia and Professions Australia, 2016). The PARN report suggests that '*improved communication between HEIs and professional associations is key to establishing closer working relations'* and the roles of the HEI and accrediting body need to be clear. The PARN report also recommended that professional associations should work within quality assurance frameworks endorsed by QQI and proclaimed that there should be more '*joined up thinking and less duplication where the same evidence could be used for both exercises*.' The research findings of the present study support these report's outcomes.

Report generation and sign off is critical to determining the power relationships and authority for these processes. 35% of participants suggest that '*the programmatic review report could wait until the accreditation reports are signed off by the accreditation board.'* Confidentiality issues and data protection concerns may arise with the passing of reports between organisations.

Power and influence are exerted at different levels, national and international. The programmatic review process is a European and national driven process whereas the accreditation process has been developed by a national policy community (Engineers Ireland) but heavily influenced by global policy communities (ENAEE, IEA). The open method of collaboration is a means of spreading best practice while achieving greater convergence towards common goals and may produce more effective and legitimate education policies (Livingston, 2003).

Policy communities have greatly influenced quality assurance in engineering education through the accreditation process. The global success of the accreditation policy reflects the inputs of the stakeholders who contributed to its creation.

The distribution of power within policy communities generally lies within the structure of the policy community. According to Ball (2012), governments have relinquished some of their privileged authoritative position. The professional associations have pushed the state back and become an equal player in the quality assurance space. A significant factor in how the professional associations use their power is that all policies and implementation processes are managed through a collaborative process within their internal structures and especially their accreditation/education boards (Ball, 2012). The voice of employers and professional practitioners is captured in this collaborative process.

Policy formation by policy communities, where stakeholders are consulted and have an active voice in the processes, ensure easier implementation and interpretation of the policy. The QQI policies are adopted and adapted by academic councils in each HEI but the interpretation of the policies is more contentious. The professional practitioner’s voices are missing from the policy formation stage, which contributes to the variety of interpretations of policy experienced at implementation stage.

Previously the programmatic review policy was acknowledged as the main quality assurance process for engineering education and the professional associations held their own examinations as the entry mechanism to their professional award titles. In the last decade or so there has been a shift towards the accreditation policy as being the dominant policy to ensure the quality of engineering education in Ireland because of the evidence-based approach used to assess the programme content and the emergence of curriculum improvement as a result. Power is equally dominant as the validation and accreditation processes are currently independent of each other and both play a gatekeeper role.

Other professional associations also have influence on engineering programmes. Eighty-eight percent of participants agreed that some engineering and construction programmes '*are not accredited by Engineers Ireland but by another professional association.*' 80% of the participants agreed that *'the aligned/combined process could be a template for other professional associations in engineering'* but the process may need to be adapted to suit their requirements which may be radically different to the Engineers Ireland accreditation criteria. Extending the template to other faculties will meet with similar challenges as well as working with regulatory bodies. The PARN report considers that sharing different accreditation processes, sharing panel documentation, sharing review panels and developing common templates would improve interactions between the primary stakeholders to the processes.

The research findings, the consensus reached by the research participants, the researcher's experience and analysis of the literature support a conclusion that the authority, power, responsibilities and influences of the primary stakeholders to the engineering education quality assurance processes determine how the processes are perceived, formulated and implemented. Bringing the processes into closer alignment will need careful consideration of the power, authority, responsibility and influential roles of the professional associations and the HEIs.

8.2.5 Research Objective Four: Method of Combination or Alignment

Research objective four of this study is '*to identify the most appropriate method of combination/alignment of the processes and to examine if the internal programmatic review process can be enhanced by using the evidence-based methodology of the Engineers Ireland accreditation process and thereby facilitate the convergence of the processes*.'

Currently, programmatic review and accreditation happen completely independently of each other. *Combining* both processes would involve the creation of an integrated process, from the existing processes, which would allow engineering programmes to be reviewed academically and professionally at the same time, in a single process. This mirrors the fact that employers seek academic and professional skills from graduates. One participant stated that the '*Engineers Ireland process could be a subset of the programmatic review process or vice versa.'* Both processes may change to create a new agreed collaborative process which would serve the requirements of both the programmatic review and accreditation processes (see question 10 of appendix U and question 3 of appendix AA).

One the other hand, *aligning* the processes could be accomplished by having both processes occur in the same timeframe, and one process happens directly before or after the other process, but both processes are completely independent of each other. An alternative version of an aligned process is a *linked* process, where the processes occur in the same timeframe, and one process happens before or after the other process, but the implementation procedures are linked between the processes. 71% of participants agreed '*that the unique elements of one process could be added into the other process.'* Aligned process options were mentioned by participants during the interviews but the linked option is entirely the concept of the researcher as a consequence of all the consultations with stakeholders and interviews with participants.

Based on the research findings, the combined option, although desired by 67% of participants in round two and 34% of participants in round three, is not practical to achieve at present. Engineers Ireland is the designated Competent Authority for the engineering profession in Ireland under the EU Directive on the Recognition of Professional Qualifications. As outlined in section 8.2.4 of this thesis, Engineers Ireland cannot cede its authority and responsibility to a third party and must demonstrate independence of the process to its international partners. HEIs have become Designated Awarding Bodies under the auspices of QQI. As outlined in section 8.2.4, HEIs cannot cede their statutory authority or responsibility to another party. Similarly, most other professional associations in the engineering and construction disciplines cannot cede their authority and responsibility to another party. The PARN report highlights these statutory responsibilities stating that the '*National quality assurance guidelines and education providers are bound by European standards and guidelines and similarly professional associations are bound by international agreements'* (PARN, 2017).

The Engineers Ireland Accreditation Review report acknowledges that '*accreditation and programmatic review serve different purposes and have a different set of programme outcomes and Engineers Ireland needs to ensure compliance with international accords.'* The report confirms that there is no clear recommendation on how alignment can be achieved '*with some survey respondents in favour of simultaneous visits, but more in favour of alignment'* (Engineers Ireland, 2019). Engineers Ireland needs to demonstrate to their international partners that the accreditation programme outcomes have been met, evidence has been appraised and an independent report has been prepared. QQI have established that the accreditation processes are in a state of flux where professional associations are either establishing new standards or updating existing standards (QQI, 2019).

The PARN report agrees that professional accreditation requirements appear to change with some regularity. The research participants argue that '*professional bodies maintain their own version of accreditation so alignment is the most workable option*.' Drawing on the literature, the research findings, and my own professional experience, I would argue that fully integrating the two quality assurance processes would lead to an unsustainable process.

Based on the research findings, the aligned/linked option, should be possible to implement where past performance and future goals could be aligned in some way. However, consensus was not reached by the participants as to how this could be achieved. One participant commented that there '*needs to be separate processes as too much is involved here*.' Nevertheless, a possible solution to bringing the processes into closer alignment, based on the research findings and professional experience, is proposed here.

The proposed linked processes could occur within the same timeframe. Hence, the processes should be no more than six months apart, ideally following directly from each other. The engineering programme could be assessed for validation and accreditation around the same point in time. Research participants expressed the opinions that '*processes occurring in the same timeframe is critical to the success of bringing the processes into closer alignment'* and '*it is possible to do two processes at the same time.'* All participant group types support this theme with civil engineers more supportive than mechanical/electrical engineers.

The accreditation process could take place directly before or after the programmatic review event. Some participants suggested that '*the processes should be run in phase*.' For the aligned scenario, the accreditation process would be independent of the programmatic review process. For the linked scenario, the Engineers Ireland process would complete some of the elements normally carried out in the programmatic review event, and feed this information into the programmatic review event to reduce the activities in that process.

Support for a linked approach also comes from the Engineers Ireland Accreditation Review report, which asked survey respondents if the programmatic review and accreditation processes should be linked or separate. Fifty-one participants responded to this question with thirty-seven respondents (73%) suggesting that the processes should be linked and fourteen respondents (27%) suggesting that the process should be kept separate. The survey respondents emphasised that the processes are almost identical and independent outcomes should be maintained. Accreditation *'should be a test of compliance, not a development tool*' was mentioned.

For an aligned/linked approach to be workable, the sequencing of accreditation and programmatic review processes needs to be carefully considered. Experience suggests that the Engineers Ireland accreditation should happen before the programmatic review event so that the outcomes of the accreditation assessment can inform the programmatic review event. In addition, the meetings with stakeholders in the Engineers Ireland accreditation process are programme specific whereas the programmatic review meetings with stakeholders are more generic. As meetings with stakeholders can be one of the more enlightening aspects of the accreditation process, these need to be programme focused to be meaningful.

In an aligned/linked approach, some of the major agenda items could then be removed from the programmatic review site visit agenda and report including:

- Programme specific recommendations;
- Meetings with stakeholders, normally employers, students and graduates;
- Tour of facilities;
- Programme details already captured in the Engineers Ireland accreditation report such as programme structure, programme management, duration, quality assurance processes and final year projects.

Support for this proposed sequencing of processes comes from both the PARN and Engineers Ireland reports. The PARN report strongly agrees that the nature of the relationship between programmatic review and accreditation should run from external accreditation to influencing the internal quality assurance processes (PARN, 2017). The Engineers Ireland report agrees that '*the accreditation visit should take place in advance of programmatic review*' and that '*ideally the accreditation visit should take place before programmatic review so that any issues arising can be tackled as part of the programmatic review'* (Engineers Ireland, 2019).

The Engineers Ireland Accreditation Review report suggests that the Engineers Ireland accreditation adequately covers what is required in programmatic review, therefore only what is unique to programmatic review should be covered in the programmatic review event (Engineers Ireland, 2019). Nevertheless, 96% of participants of the present study agree that some changes are needed to both processes to accommodate each other. More detailed mapping is needed to determine overlaps and unique elements of each process so that a robust process can be piloted in a number of HEIs before implementing it nationally.

Ninety-two percent of participants agree that '*significant parts of one process can be transferred into the other process.'* The evidence review is considered by participants to *'be a fundamental part and strength of the Engineers Ireland accreditation process.*' 83% of participants agree that '*the evidence review should be included in the revised process.'* A smaller evidence review already exists in the programmatic review process and, hence, most participants agree that the evidence review should form part of the final process. One participant expressed the view that *'the evidence review could be done before the programmatic review process.*' All participant group types support this view and there is a reasonably even distribution of participant responses across the engineering disciplines.

The evidence from previous reports and the findings of this research supports a proposal that the HEI programme teams could submit one document which would have all the required information for both processes which would reduce duplication and work effort. Review panels would have sight of all the relevant information for both processes and be more informed prior to the site visit. There is almost complete agreement (96%) across all the participants in round three of this study that the HEIs should produce one set of documents which would cater for both processes '*even if some parts are not relevant for one party.'* The PARN report reached a similar conclusion and suggested that '*streamlining the system through reduced duplication and reducing documentation requirements overall would be helpful*.' Online submission of documentation could alleviate some of the effort. All participant group types support one document submission with similar responses across the engineering disciplines.

This research study confirms that both quality assurance processes have different drivers, motivations, biases and stakeholders. The participants reached consensus on the following in relation to combining/aligning the processes:

- Could bring coherence to the quality assurance by providing linkage between professional and academic engineering education;
- A process should be agreed between HEIs, QQI and Engineers Ireland;
- The evidence review should be included in the final process;
- Significant parts of one process can be transferred into the other process;
- The quantity of work for one panel could be reduced;
- Other professional associations could attend in the Engineers Ireland time slot;
- Chairs of accreditation panels could sit on the programmatic review panel.

In round three of this study, 80% of participants suggested that the aligned processes could be a template for other professional associations in the engineering and construction sphere but the process would have to be adapted to suit each professional association requirements (see section 8.2.4 of this chapter and question 4g of appendix AA themes summary document).

All of the evidence presented so far, whether derived from previous reports or the research reported here, leads to a recommendation that a linked accreditation/programmatic review process would allow the statutory authorities to conduct their review of engineering programmes, minimise duplication of effort and maximise efficiencies. This recommendation is consistent with the consensus reached by participants for aligning/combining the processes. Alternatively, an aligned process where the Engineers Ireland accreditation process would occur in the same time frame could achieve the same goal.

8.2.6 Research Objective Five: Voluntary or Mandatory Accreditation

Research objective five for this study is '*to investigate if the Engineers Ireland accreditation process should be voluntary or mandatory when the processes are in closer alignment*.'

From round one of the data collection, 69% of participants mentioned that accreditation should be voluntary. This percentage reduced to 58% in round two and 56% in round three. 31% of participants considered that accreditation should be mandatory in round one and this increased to 50% in round two and reduced to 26% in round three. There is no consensus on voluntary or mandatory accreditation, but the majority of participants suggest voluntary.

Thirty-five percent of participants recommend that the '*voluntary nature of the accreditation process should not be compromised*.' 75% of the participants affirm that '*the combined processes would effectively make accreditation mandatory whereas aligned processes could allow for accreditation to be voluntary.'* 26% of participants believe that *'accreditation should be mandatory for programmes with B.Eng. awards as all students and employers expect accreditation.'* Discretion may be needed for some programmes in faculties/schools of engineering (software engineering, computer science, etc.). In this thesis, Tables 5.4 to 5.6, 5.9, 6.1 to 6.5, 6.8, 6.12 to 6.24, 7.1 to 7.3 and 7.6 to 7.16 give the details of how this theme was examined through the three data analysis stages as this question was selected to be the example for readers to follow. Appendix AA themes summary document (question 2) provides some narrative summaries that are not illustrated in the body of this thesis.

All participant group types support the concept that the accreditation process should remain voluntary, especially the registrars and management staff. More mechanical/electrical engineers corroborate this theme than civil engineers. All participant group types support the theme that accreditation should be mandatory for programmes with B.Eng. awards, especially the academic staff. The mandatory theme is more popular with the civil engineers. More civil engineers than mechanical/electrical engineers support the HEIs having the option to apply for accreditation which resonated mostly with the registrars and heads of faculty.

Professional associations are gatekeepers to the engineering and construction professions and it is the professional associations who will determine whether the processes are voluntary or mandatory. The SCSI has a voluntary accreditation process with essential compulsory elements. There is concern among participants '*that a mandatory process would allow professional associations too much power.*' It is worth noting that no other professional association in the engineering and construction sphere has mandatory accreditation. The statutory framework to made accreditation mandatory is not in place. Therefore, it should remain the HEI's choice whether to apply for accreditation and this is mentioned by 31% of civil engineering participants as the accreditation process is more relevant for the civil engineering discipline than the other engineering disciplines.

The Engineers Ireland Accreditation Review report argued that '*there is no requirement in some roles for engineers to be chartered so why would the process be mandatory?'* The report claims that '*the accreditation process should be voluntary'* to ensure there is continued benefit to students and it should remain a HEI's choice whether to apply for programme accreditation (Engineers Ireland, 2019).

The participants reached consensus on the following aspects of this objective:

- A mandatory accreditation process would remove confusion as to which programmes are accredited by Engineers Ireland;
- Combining programmatic review and accreditation into a single process would make accreditation mandatory.

In light of the views expressed in the previous reports and by the research participants, it is recommended that the accreditation process remains voluntary and it is the HEI's choice to request the relevant professional association(s) to accredit its programmes. This opinion is consistent with the Engineers Ireland recommendation and is not in conflict with the consensus reached by participants.

8.2.7 Research Objective Six: Review Cycles and Site Visit Agenda

Research objective six for this study is '*to determine and appraise the most suitable synchronisation of the review cycles and changes to the site visit agenda(s) of the programmatic review and accreditation processes to facilitate closer alignment*.'

A combined/aligned process includes self-evaluation, mapping to QQI standards and Engineers Ireland criteria, evidence gathering and site visit. Synchronisation of the review cycles is necessary for integration and coherence of the processes. The review period should be in phase to minimise duplication of work. All of the research participants (100%) confirm that '*synchronisation of review cycles can be achieved, but it may take a couple of iterations*.' Engineers Ireland is amenable to a one-year extension or two-years in exceptional circumstances. Nearly all (96%) of the research participants agree '*a review cycle of five years would align with programmatic review and international best practice.'* The rate of engineering development suggests that the review period should not exceed five years. 83% of participants agree that there should be '*one comprehensive review including accreditation every five years*.' A combined/aligned process every five years is more popular with the civil engineers than the mechanical/electrical engineers but has support from all group types.

The ENAEE recommends a review period of five years and the IEA operates a review period of six years. 63% of participants (mostly mechanical/electrical engineers) stipulate that for some technology areas five years is too long and '*an interim review is possible*' to complement the five-yearly review. The Washington Accord allows a shorter cycle than five years by external examiner input '*but it is not easily implemented*.' A timeline greater than five years would need agreement from stakeholders and if programmatic review goes to a seven-year cycle, '*it will prevent synchronisation*.' The highest frequency of periodic cycle in the PARN report is five years with very few cycles greater than five years and some have three-year cycles or happen annually. The PARN report identifies nineteen HEIs who have an institute wide policy on accreditation and of these seven HEIs report their policy is to ensure alignment between quality assurance and external accreditation processes. This includes '*synchronising review cycles and collating a myriad of different body reviews'* (PARN, 2017). The Engineers Ireland Accreditation Review report also agrees with the research findings and recommends that *'the processes should be synchronised as they are based on the same evidence'* (Engineers Ireland, 2019). Aligning of the review cycles has support from all group types and engineering disciplines.

Seventy-nine percent of participants agree that the agenda for the programmatic review process is set by the HEI's academic council and evolves over time. 96% of participants agree that the agenda for the Engineers Ireland accreditation process is set by the accreditation board and evolves over time. 88% of the participants suggest that '*the agenda for an aligned/linked process should cater for the objectives of both processes.'* All participant group types agree with this suggestion which has more civil engineer support than mechanical/electrical engineer support. A combined/aligned process should require less frequent staff and stakeholder commitment. The narrative summaries for questions 11 and 13 of appendix O, questions 5 and 16 of appendix U themes summary document and questions 3 and 4e of appendix AA provide the analysis of participant views for synchronisation of the review cycles and changes to the site visit agenda(s).

Eighty-seven percent of participants recognise that '*extra time will be required for the site visit.*' 65% of participants suggest that '*the duration of the site visit should be limited to between 2 days and 2.5 days*' as there are process commonalities and it would be difficult to get panel members for more than 2.5 days. Although all participant group types note that extra time could be required if the processes are fully integrated, there was an even distribution of responses across the engineering disciplines. The Engineers Ireland Accreditation Review report recommends that the length of the visit could be reduced by preview of electronic evidence or an increase in the use of technology (Engineers Ireland, 2019). In some HEIs the programmatic review can be in two stages; strategic review and programme assessment. The programme assessment stage could be the stage of the process linked to the Engineers Ireland accreditation event.

The research findings could apply equally to extending the combined/aligned process template to other professional bodies, to other faculties within institutes of technology or to any university that had a five yearly quality assurance process for education programmes.

The consensus reached by the research participants is consistent with the literature and the linked/aligned processes recommended by the researcher. The next recommendation arising from this research is therefore that the review cycle for both processes is synchronised at five years and that the agenda for the Engineers Ireland process does not change, but the agenda for the programmatic review process reduces substantially for the linked process as set out in section 8.2.5 of this chapter.

8.2.8 Research Objective Seven: Validation and Accreditation Objectives

Research objective seven for this study is '*to explore and critically evaluate the possibility that the validation and accreditation objectives can converge into a single set of objectives to support the alignment/combination of the quality assurance processes*.'

Ninety-two percent of participants agree that '*similar validation and accreditation objectives between the two processes generates considerable overlaps in the execution of the processes*.' 71% of the participants claim that the validation and accreditation objectives were created in isolation from each other and do not coincide at present. 75% of participants agree that '*one collaborative process needs to be agreed between QQI, HEIs and Engineers Ireland.'* Programme outcomes and objectives could be the same for both processes where the HEI's academic council and Engineers Ireland's accreditation board agree the full range of programme outcomes for the appropriate level of professional title.

Seventy-five percent of participants concur that '*the QQI Engineering award standards and Engineers Ireland accreditation criteria need to be aligned in terms of objectives and outcomes.'* Two participants suggest that '*the current objectives are reviewed to create a single set of requirements for QQI and Engineers Ireland*.' The initial consultation with stakeholders that comprised the first phase of the present study included a review of the Engineers Ireland accreditation criteria, the QQI engineering award standards and the QQI professional award type descriptors. Twenty-four triangulation documents were prepared to compare the three standards/criteria. This allowed for comparison across the three engineering professional titles, their equivalent NQF levels for the three strands of knowledge, skills and competence and the five sub-strands of mathematics and sciences, design and development, information technology, business context and engineering practice. Tables 4.2 and 4.3 show samples of these comparison tables and further samples of the full comparison tables can be found in Appendix C of this thesis. Even though there are differences in wording between the standards/criteria, it has emerged that there is a level of agreement between all of the documentation of over 90% in terms of intent. The creation of the triangulation documents has highlighted that the QQI standards and Engineers Ireland accreditation criteria are already very closely aligned and it would not be a major undertaking to bring them into full alignment. Agreement between the main stakeholders would be required and discussions between QQI and Engineers Ireland continue. If this can be achieved, then the alignment of programme outcomes across the processes would be the next phase of this endeavour.

All of the participant group types support all of the research findings but differ across the engineering disciplines. There is good support across all the engineering disciplines for the theme that the validation and accreditation objectives do not coincide at present. Civil engineers emphasise more strongly than the mechanical/electrical engineers that a collaborative process will need agreement from the primary stakeholders, with mixed views from the mechanical/electrical academic staff. The need to align the standards/criteria was more popular with the civil engineers. Question 7 of appendix U provides more information.

The Joint Statement of Principles for Professional Accreditation encourages '*national consistency of the professional accreditation standards and process at the discipline level'* and consistency at the level of principle in a discipline's requirements. The Joint Statement also encourages '*that professional accreditation processes should base the evaluation of university programmes on the published professional accreditation standards.'* Professions Australia and Universities Australia share a responsibility to develop complementary approaches to programme accreditation as well as the alignment of professional standards and the learning outcomes requirements of the Higher Education Standards Framework of Australia (Universities Australia and Professions Australia, 2016). This document will assist with the development by QQI of an Irish set of accreditation principles and supports the research findings.

The consensus reached by the research participants is consistent with the literature and the support for linked/aligned processes arising from this research. It is further recommended that the validation and accreditation objectives and programme outcomes could be fully aligned.

8.2.9 Research Objective Eight: Communication and Liaison Between Organisations

Research objective eight for this study is '*to identify and scrutinise how communication and liaison can be managed between stakeholders and organisations for the revised process(es).*'

Ninety-two percent of participants agree *'that all communication including liaison, report generation, sign-off and sharing needs to be agreed between HEIs, QQI and Engineers Ireland'* so that they can achieve their requirements in a reasonable timeframe. On occasion, there can be a disconnect between the HEI and the professional association, so an agreed protocol would ensure continuity of the process(es).

According to the PARN report, '*standardising how professional associations are communicated with should lead to greater resource efficiencies and communication should be improved between the main stakeholders*.' Some inefficiencies from professional associations are noted in the PARN report including poor understanding of the HEIs' educational standards, incompetent reviewers and slow application and approval processes (PARN, 2017).

The Engineers Ireland's Registrar normally communicates with the HEI's Dean/Head of School of Engineering but the research participants also mention the programme team or the HEI registrar as alternative points of contact. 83% of participants agree that liaison between organisations should be managed by the Dean/Head of School in consultation with the Heads of Department, the HEI registrar and the Engineers Ireland Registrar. This method of liaison has support from all participant group types and engineering disciplines (See question 18 appendix U).

There are different panel members for each quality assurance process in each HEI. 88% of participants envisage that '*the programmatic review panel could encompass the accreditation panel where the chairs of the accreditation panels could sit on the programmatic review panel and present findings to the Engineers Ireland accreditation board.'* One panel could review the strategic direction of the unit/programmes and the accreditation panels could assess the programme evidence. In the aligned model the panels would be fully separate but in the linked model the panels could be separate or connected. 96% of participants agreed that '*the review panel(s) should be constituted to meet the needs of both processes*.' All participant group types, except the academic staff, support these views and there is consistency of the responses across the engineering disciplines (See question 9 appendix U).

Normally, a programmatic review panel has between four and ten members to assess in the order of twenty programmes, and an accreditation panel has three members per programme. The combined option would have a wider panel with more subject experts at programme level. For the aligned option, participants select two panels as there are different sets of objectives and outcomes (validation and accreditation). The PARN report recommends that the range of people participating in review panels should be broad and include both academics and professionals. The QQI Insights report recommends the involvement of site visit panel members from other countries to assist with the removal of bias and the achievement of best practice (QQI, 2019).

Eighty-eight percent of participants agree that '*the weakness of the Engineers Ireland accreditation panels is consistency and competency of panel membership who may be biased.*' Panel member training and guidance could lead to different process outcomes. One participant suggests that '*the training of programmatic review and accreditation panel members could be a better way to ultimately merge the processes and bring together minds through training*.' All participant group types and engineering disciplines mention the lack of panel member training and consistency in competency (see question 9 appendix U and question 3 appendix AA). The PARN report agrees and recommends that '*training for academic staff involved in accreditation should be provided*' (PARN, 2017). The roles and responsibilities of Professions Australia is set out in the Joint Statement of Principles for Professional Accreditation report and includes ensuring that '*members of professional accreditation panels are appropriately skilled, trained and supported'* (Universities Australia and Professions Australia, 2016). The Engineers Ireland Accreditation Review report also agrees and states that the *'panel volunteers need to be better supported, trained and incentivised'* (Engineers Ireland, 2019).

Agreeing protocols among the main stakeholders for report generation, sign-off and sharing is critical to bringing the processes into closer alignment. Engineers Ireland could have independent reports which could form part of the programmatic review process '*as an annex to the programmatic review report.'* 58% of participants suggest that '*the final programmatic review report could wait until the accreditation reports are signed off by the accreditation board.'* Confidentiality and data protection concerns may arise with the passing of reports between organisations. All participant group types and engineering disciplines support these views (see question 16 appendix O, question 18 appendix U and question 4d appendix AA).

The programmatic review panel could have sight of the Engineer Ireland accreditation reports where their conditions and recommendations could be observed. This may eliminate any conflicting conditions and recommendations in the programmatic review reports. The QQI Insights report noted that almost all professional associations allow for conditions and recommendations to be included in the accreditation panel reports and that it would be prudent for each professional association to have a clearly defined appeals process (QQI, 2019). Professional associations having *'an effective complaints and appeals process'* was also mentioned in the Joint Statement of Principles for Professional Accreditation. The Engineers Ireland Accreditation Review report suggests that an appeals process should be put in place (Engineers Ireland, 2019).

Sixty percent of participants would '*prefer to have a single report'* for the combined scenario but 40% of participants recognise that *'there should be two separate reports as they go in different directions'*, to different reporting areas and have different emphasis in process implementation. The professional association representatives selected the two separate reports option which is highly significant (see question 4d appendix AA). Any time lapses in approval of the Engineers Ireland reports would impact significantly on the programmatic review timelines. The Engineers Ireland Accreditation Review report mentions that a timely response to accreditation reports is needed and that the use of a proforma template online would be welcome. 75% of the participants agree that '*the single report could have one section on strategic/common issues, one section on the programmatic review and one section on the accreditation reports*.' More civil engineers than mechanical/electrical engineers supported this view (see question 18 appendix U). 75% of the participants expect publication of the programmatic review reports but not for the Engineers Ireland accreditation reports and participants recognise that this may change if the processes are in closer alignment.

Other professional associations could include representatives on the programmatic review panel and this should be possible for panels in other faculties/schools. Any report sharing between a HEI and a professional association needs a high-level agreement between them.

The consensus reached by the research participants is consistent with the literature and the linked/aligned processes recommended in section 8.2.5 of this chapter. The next recommendation arising from the research is that communication and liaison between organisations should be agreed in a high-level protocol and be managed between the Engineers Ireland Registrar and the HEI Dean/Head of School of Engineering. It is also recommended that the constitution of the programmatic review panel should include a mix of academic, industry, Engineers Ireland representatives and international members noting that the volume of documentation can have a negative effect on industry participation on panels. The accreditation panel of three members per programme should continue to allow an adequate assessment of the programme evidence. Training should be encouraged for all panel members to ensure adherence to quality assurance processes. For the linked/aligned processes, two reports are recommended, within the same timeframe, where the accreditation report is approved by the accreditation board and added, in a separate section, to the programmatic review report to minimise confidentiality and data protection concerns. An appeals process should be put in place.

8.2.10 Research Objective Nine: Validation and Accreditation as Independent Outcomes

Research objective nine for this study is '*to evaluate and investigate if validation and accreditation should remain independent outcomes*.'

One difficulty with achieving this objective is that an engineering programme '*may be validated to one NFQ level but accredited to one of three professional titles*.' There are also three nuances of validation and accreditation reports; conditions, recommendations or both. There are different process objectives which may lead to different conditions and recommendations in the panel reports. 91% of participants agree that '*non-standard entry to programmes should not affect their ability to be accredited.'* 52% of participants consider that judgement of non-standard entry to programmes should only be on the basis of student achievement of learning outcomes and this may require HEI's recognition of prior learning to be more robust for engineering programmes. All participant group types and engineering disciplines support this theme (see question 6 appendix AA themes summary document).

Sixty-seven percent of participants agree that '*there should be one report for the combined (single) process option*' as there is no advantage to have different recommendations and conditions vying with each other. More civil engineers than mechanical/electrical engineers support this option (see question 11 appendix U). A participant states that there '*should be one outcome only for B.Eng. awards*' (validation and accreditation together, or neither). This is consistent with the participant's view that B.Eng. awards should all aspire to be accredited.

Nearly all participants (91%) agree that *'it is appropriate to have two independent process outcomes of validation and accreditation'* as a programme may meet validation requirements but not the accreditation criteria. 73% of the participants associate the two process outcomes with the aligned option and 54% believe that '*validation and accreditation are two separate decisions.'* All participant group types and engineering disciplines support the two outcomes approach (see question 17 appendix O, question 11 appendix U and question 4c appendix AA themes summary document). The Engineers Ireland Accreditation Review report concurs that '*there should be two different outcomes*' (Engineers Ireland, 2019).

The consensus reached by the research participants is consistent with the literature and the linked/aligned processes recommended in section 8.2.5 of this chapter. The final recommendation emerging from this research is that validation and accreditation remain as independent outcomes as they are two separate decisions.

8.3 Unexpected Findings

The Delphi technique sampling is very purposive as experts are selected for their expertise, experience and willingness to partake in the research. In addition, the researcher has many years of engagement with the programmatic review and Engineers Ireland accreditation processes as a Dean of Faculty and as a panel member assessing programmes. For those reasons, only a small number of unexpected findings have emerged from this research.

8.3.1 Changes in the Higher Education Landscape

Since the beginning of this research study in 2014, there have been many changes to the higher education landscape. Three substantial changes, which have the potential to have a major impact on the possibility of bringing the process into closer alignment, are institutes of technology becoming designated awarding bodies in January 2020, the creation of merged technological universities and the development of new generation apprenticeships.

Institutes of technology are designated awarding bodies since January 2020, which means that they have the authority, under the auspices of QQI, to create their own quality assurance processes. Up to January 2020, all institutes of technology's programmes had to undergo programmatic review with a review period between five and seven years. The programmatic review process differed slightly in each institute of technology but was fundamentally the same. For the first time, institutes of technology can have very different internal quality assurance processes with varying review cycles but are likely to stay close to the current systems in the short term. All the institutes of technology's academic councils have adopted the current QQI standards.

Technological universities can be created when two or more HEIs merge. The merging of engineering programmes between HEIs could cause a change to the review cycle for accreditation and programmatic review in one or more HEIs.

The first engineering new generation apprenticeship was offered in September 2016 with the first graduates in June 2018 and accreditation by Engineers Ireland in 2020. Apprenticeships have traditionally been NQF level six programmes and were not accredited by professional associations. Accreditation of apprenticeship programmes has changed the quality assurance processes to account for on-the-job training. Accreditation of apprenticeship programmes is evolving and could interfere with the established process and review cycles.

8.3.2 Engineers Ireland Accreditation Process Variations

Two of the research participants mentioned variations to the Engineers Ireland accreditation process as possible methods to bring the processes into closer alignment. These included a continual audit approach, expansion of the external examiner role and annual reporting to Engineers Ireland.

A continual audit type review where programme evidence is submitted online annually to trained and experienced auditors (or a day onsite to review evidence) is a possible approach. The HEI's annual reporting template to academic council could be adapted for this purpose. The auditor approach avoids the vagaries and prejudices of untrained panel members and may reduce costs. When this approach was put to the participants in round three of the data collection, only 30% of the participants supported the approach and it resonated mostly with heads of faculty and mechanical/electrical engineers.

The role of the external examiners could be expanded to complete an evidence review of the relevant programmes each year as part of their reporting to the HEI. The Washington Accord allows for a shorter cycle than five years by external examiner input but participants believe that it is not easily implemented.

The Engineers Ireland Accreditation Review report mentions that the length of the site visit may be reduced if there is annual monitoring by, or reporting to, Engineers Ireland on an online proforma template. In effect, Engineers Ireland would be adjusting from a five-yearly event to an annual event. The SCSI have experimented with this approach and are returning to the five-year cycle. The five/six-year review period is operated by ENAEE and IEA. Therefore, annual monitoring is unlikely to be implemented.

8.3.3 Other Unexpected Findings

Alignment/combination of the processes was considered at an Engineers Ireland conference in the nineties but the decision, at the time, was to keep the processes separate. One participant proposed that ten experienced and trained panel members could be the programme panel chairs for the accreditation reviews in all HEIs, to improve consistency across the sector, and replace them every three to four years. In this study, 23% of participants state that there are no disadvantages to combining/aligning the processes and 15.5% of the participants suggest that there are no barriers. The majority of participants disagreed with this view.

8.4 Limitations of This Research

The findings of this study have to be seen in light of some limitations. The limitations are grouped under three categories of scope of the research, methodological limitations and limitations of the researcher.

8.4.1 Scope of the Research Limitations

The limited ability to generalise the research findings is predominantly caused by restricting the comparison of the programmatic review process to only the Engineers Ireland process. The primary limit to the generalisability of the research is its applicability to accreditation processes of other professional associations. Other limiting factors to the generalisability of this research is in the research study’s applicability to programmes outside the engineering discipline, to programmes in universities and to programmes outside of Ireland.

Every professional association has its own accreditation process. In the construction discipline, professional associations (SCSI, CIOB, RIAI, CICES, and others) have their own accreditation criteria and accreditation process. HEI programmes are mapped to the various accreditation criteria to determine whether they meet the criteria. Some criteria are similar to Engineers Ireland and some are radically different (RIAI). The research design was formulated to bring the Engineers Ireland accreditation process into closer alignment with the programmatic review process and then adapt this outcome to other professional association processes. The researcher’s proposed linked process provides the capacity to include other professional associations’ accreditation criteria/process in this linked process. Future research can build on this recommendation by mapping the accreditation processes of other engineering and construction professional associations to the HEI’s internal quality assurance process to create specific linked processes for each professional association.

HEI programmes outside the engineering and construction field have accreditation processes with professional and regulatory associations, some of which have statutory obligations. Limiting the research to the Engineers Ireland accreditation process did not allow exploration of these accreditation criteria. The researcher’s proposed linked/aligned processes provide a window for these professional associations to link to the HEIs’ internal quality assurance process. Further research can map the accreditation criteria/process of the professional associations outside of engineering and construction to the programmatic review process.

University programmes tend to have regular quality reviews rather than one major process every five years. University programmes were not included in the research design as the programmatic review process is not normally part of universities' quality assurance processes. Thus, the research findings are not applicable to university programmes in Ireland. Future research could determine if it is feasible to link the quality assurance processes of engineering university programmes to the Engineers Ireland accreditation process.

The QQI programmatic review process pertains to higher education programmes in Ireland. Other jurisdictions have their own quality assurance processes which are similar if the jurisdiction is a member of ENAEE. This research utilised the programmatic review process as the HEI's internal quality assurance process so the research findings are not applicable in other jurisdictions. Further research could establish whether a link between HEIs internal quality assurance processes and their engineering professional associations in ENAEE member jurisdictions is feasible.

8.4.2 Methodological Limitations

Methodological limitations in this research study is caused by the methods used to carry out the data collection and analysis, the selection of the research participants, the lack of previous studies on this topic, the exclusion of the student and employer voices and not reaching participant consensus on all the themes.

It is widely accepted that the Delphi technique for data collection has high validity, as the research participants are experts in the study area, and low reliability. Thangaratinam & Redman (2005) argue that the findings in one study can be tested or confirmed in another study with a different sample as a means of validation. The findings of the present study were able to be compared with relevant reports conducted contemporaneously with this research. These reports included the Engineers Ireland Accreditation Review that surveyed ninety academics and almost one hundred and fifty employers and came to similar conclusions (Engineers Ireland, 2019). Similarly, the PARN report and the QQI Insights report both agree with the majority of the research findings (PARN, 2017), (QQI, 2019). Other measures taken by the researcher to improve reliability include the keeping of a research journal to demonstrate a clear decision trail, having interviews as the first round of the Delphi technique, providing feedback loops to participants and using justifiable consensus levels. Based on these considerations, the reliability of the research findings should be sound.

Participant selection bias could be a feature of this research study as most of them are known to the researcher. The researcher carefully balanced the number of participants selected from each group type and engineering discipline at the three organisational levels. There was an inefficient sample size for statistical measurement for the group type and engineering discipline analysis. Therefore, this information was provided only as an indicator of trend in the research findings. With a larger sample size at one organisational level, future studies could explore the difference in attitudes of participants across the three engineering disciplines (civil, mechanical, electrical) to the accreditation of engineering programmes.

Grounded theory has limitations (see section 3.6.4) including transferability of research findings and identifying theoretical saturation (when participant consensus is reached). Participant consensus for all but three of the emergent research themes was reached using the median, percentages and interquartile deviation measures (see sections 6.5.1 and 7.5.1). A rationale was provided for determining theoretical saturation in section 7.5.1 even though consensus was not achieved for all themes. Future research could examine the appropriateness of the accreditation processes being voluntary or mandatory for engineering and construction programmes across a range of professional associations.

There are many research studies on the quality of engineering education, accreditation of engineering education in many countries of the world, including Ireland (Thomas, et al., 2015). Most studies link accreditation to the higher education systems of the relevant jurisdiction. However, research output is scarce in relation to bringing quality assurance processes into closer alignment with the accreditation processes in engineering and construction education and this area needs further development in future research.

There is a lack of previous studies on the topic of merging the QQI standards and professional accreditation criteria. The researcher has prepared comparison documents for the Engineers Ireland criteria but this could be expanded in future research to programme outcome alignment and to other disciplines.

The research participants were selected according to their experience of the quality assurance and accreditation processes which limited the selection to HEI staff and professional association staff. Participants had to have experience of the process to be able to answer the researcher’s questions. The student and employer voices were thus excluded from the study. Future research could address the benefits to employers and students of having an engineering qualification that is academically and professionally reviewed.

8.4.3 Limitations of the Researcher

Limitations of the researcher included access to participants, time constraints, cultural bias and personal bias. Some potential research participants agreed to participate in the research but due to organisational and personal commitments were unable to contribute. One such potential participant was a QQI representative which would have added an important perspective to the research. The researcher met with QQI and Engineers Ireland to gain their perspective in another manner. Many of the research participants are very busy managers and academics and scheduling of interviews in particular caused delays in the execution of the research design. Three participants from round one did not complete the other rounds of data collection. The researcher endeavoured to contact the three participants and concluded that they were no longer interested in continuing with the research.

Participant contact was limited to one hour in total as per the research design and ethical approval. Participants were scheduled to complete round two in fifteen minutes but ‘Survey Monkey’ confirmed that the average time was twenty-two minutes. The number of interview questions asked in round three was redesigned to compete the interviews in the remaining time. The round three interviews were shorter and more to the point which suited the iterative nature of the Delphi technique. Data was collected from the participants at three different points in time (an average of a year apart). Future research, using the Delphi technique, should allow for a longer portion of time in the questionnaire data collection phase(es).

The researcher’s cultural and personal biases may have affected the research findings. The researcher’s familiarity with the existing quality assurance processes may have limited the scope of the research question in terms of innovation and the creation of alternative methods of aligning/combining the processes. The researcher’s experience and assumption that the programmatic review and Engineers Ireland accreditation procedures are unlikely to fundamentally change in a combined/aligned process may have influenced how research questions were framed, and therefore answered. Future research could investigate alternative methods of bringing the processes into closer alignment, other than combining or aligning the existing quality assurance processes. Some examples are given in the unexpected findings section 8.3.2 of this chapter.

8.5 Primary Implications of the Research Findings

The findings of this research study have implications for engineering education, professional associations, policy and policy makers and for engineering practice. The implications are discussed with reference to an aligned or linked process replacing the existing separate processes.

8.5.1 Implications for Engineering Education

The implications for engineering education will be considered in terms of their possible effects on engineering education programmes, HEIs and their quality assurance processes, management and academic staff, students and graduates.

The aligned/linked processes are to be reviewed academically and professionally where past performance and future goals are examined in the same time period. Careful mapping of the programmatic review and Engineers Ireland accreditation processes will identify the unique elements of the programmatic review process which will formulate the revised programmatic review process for the linked option. The programmatic review process would not change for the aligned option. The programmatic review and accreditation processes would continue as drivers for the development and design of engineering programmes. The Engineers Ireland accreditation process would not fundamentally change and would continue as a test of compliance to international standards. Accreditation will remain voluntary where the HEI has the choice to apply for accreditation. Engineering programmes would continue to be assessed by the Engineers Ireland evidence review. There would be one set of objectives for validation and accreditation which would ease the re-design of the engineering programme during the self-evaluation stage of the programmatic review process. One document would be submitted by the programme team for validation and accreditation of the engineering programme so the same timeline is crucial for the linked/aligned options. The voluntary accreditation process, and the use of the same time-slot by other professional bodies, could assist schools of engineering to accredit their programmes in the same timeframe. Programme specific feedback would be retained as well as the programme specific meetings with employers, students and graduates. Two reports per programme, one each for the validation and accreditation decisions, would be generated, signed-off and approved by the relevant review panel. The programmatic review panel would have sight of the accreditation panel reports which should ensure consistency of programme conditions and recommendations.

HEIs need to ensure that the strong participant endorsement of the programmatic review process contributing positively to the quality of engineering education continues. Bringing both quality assurance processes into closer alignment is strongly supported by participants. The HEI will continue to be a primary stakeholder and gatekeeper as it cannot cede its responsibilities for validation to another party. Programmatic review process commonalities with the accreditation process will lead to a less complex programmatic review process for HEIs to manage. HEIs will have the option to apply for accreditation and can manage costs based on the number of programmes for accreditation. Consequently, there may be schools of engineering with B.Eng. award programmes that are not accredited by a professional association. A common review cycle of five years, together with running the processes in phase, will support the alignment/linking of the processes. One set of validation and accreditation objectives will make engineering programme design less complicated. Savings will be made in the time and effort undertaking the self-evaluation of both processes in the same document and preparing for site visits with the same programme evidence. Composition of review panels does not need to change for the aligned or linked processes but there will be less work for the programmatic review panels to complete even though the panel examines more programmes. The HEI's academic council needs to accept the evidence review and other elements completed by the Engineers Ireland accreditation panels as part of the programmatic review process in the linked scenario, which would not apply to the aligned model. Training for consistency and competency of panel members would be held for the programmatic review process. The programmatic review agenda would be altered by the academic council. The scale of reduction of the programmatic review agenda and the duration of the programmatic review process will be determined by the common elements across the processes. Two reports will be generated for the aligned/linked processes. In the linked model, one report per programme will be prepared during the accreditation process, agreed by the Engineers Ireland accreditation board and added as an annex to the programmatic review report. Agreement between the primary stakeholders to the processes, at a high level, is necessary to allow publication of the accreditation reports, minimise confidentiality and data protection concerns and provide consistency in report conditions and recommendations. The addition of an appeals process for HEIs to the accreditation process would be welcome. There would be two independent outcomes of validation and accreditation. Validation would continue to be decided by the programmatic review process and accreditation would be decided by the relevant professional association.

Management and academic staff participants strongly support the concept of bringing the processes into closer alignment. The management and academic staff are often panel members in other HEIs so they experience programmatic review and accreditation from both sides. The aligned/linked process should be managed between the Engineers Ireland Registrar and the HEI's Dean/Head of School of Engineering. For the linked model, operating to one set of objectives and the reduced programmatic review process will create time for staff to engage in other initiatives. Not duplicating work, and the submission of one document by the programme team for both processes, will improve staff buy-in as accreditation is not seen as a priority for some academic staff. Management and academic staff are very supportive of the Engineers Ireland's evidence review approach to assessing engineering programmes which will continue to be part of the aligned/linked options. The aligned/linked processes will continue to interrupt the academic cycle but only once every five years. Panel member training to improve consistency of accreditation and programmatic review outcomes was requested by the management staff and will be needed for both processes.

Students are the principal beneficiaries of the quality assurance processes where engineering programmes are aligned with modern technologies and current engineering practice. Engineering programmes that are academically validated and professionally accredited provide students with the best possibility of gaining employment in Ireland and throughout the world. Accreditation of their qualifications allows students to work as engineers in countries which have mutual recognition agreements with the IEA. Students are often included in programmatic review panels or are interviewed by programmatic review or accreditation panels. Student inclusion on panels or programme specific interviews will not change in the aligned or linked model. Students expect engineering programmes (B.Eng. awards) to have Engineers Ireland accreditation but it will remain the HEI choice whether to apply for programme accreditation.

Similar benefits apply for graduates of engineering education programmes to those of students. Graduates partake in programmatic review panels and may be interviewed for the programmatic review and/or the accreditation process. The aligned/linked process will not alter this arrangement. Engineering programmes that have validation and accreditation assists graduates in gaining employment in engineering practice and allow them the mobility to gain engineering practice employment in many countries, especially those countries who are members of the IEA.

8.5.2 Implications for Professional Associations

The implications for professional associations will be considered in terms of their possible effects on the Engineers Ireland accreditation process, on other engineering and construction professional association accreditation processes and on professional association accreditation processes outside of engineering and construction.

Engineers Ireland needs to ensure that the strong participant endorsement of the accreditation process contributing positively to the quality of engineering education continues. Bringing the accreditation process into closer alignment with the programmatic review process gained strong support from participants. Engineers Ireland will continue to be a primary stakeholder and gatekeeper as it cannot cede its responsibilities for accreditation to another party. The Engineers Ireland accreditation process should not significantly change in the aligned/linked process. Agreement between the primary stakeholders to the processes, at a high level, is necessary to confirm the authority and shared responsibility procedures, taking into account the limits of the academic council's and the accreditation board's areas of authority. A joint overseeing group for decision making between organisations may be required for changes, including changes to accreditation criteria. The influence of the accreditation process will increase substantially in the linked process. The timing of accreditation to coincide with the programmatic review processes in HEIs will be challenging for Engineers Ireland as there may be less tolerance for slow application and approval procedures. Voluntary accreditation will allow HEIs to have the option to apply for accreditation and Engineers Ireland will continue to set the costs for accreditation. Accreditation is pertinent for civil engineering employment as chartered civil engineers are required to sign-off designs. Engineers Ireland are members of European and international engineering accreditation organisations and are signatories to international mutual recognition agreements. Consequently, Engineers Ireland must demonstrate to their international partners compliance with these agreements and accords. The aligned/linked processes should not interfere with these arrangements. A review cycle of five years will support the alignment/linking of the processes and follow best practice internationally. One set of validation and accreditation objectives are unlikely to change the accreditation criteria as they are already very closely aligned. The submission of programme documents, containing the accreditation and programmatic review information, will assist the accreditation panels in their deliberations.

Composition of review panels do not need to change for the aligned or linked processes but the challenge of staffing accreditation panels remains. For the linked option, the HEI's academic council needs to accept the evidence review and other elements completed by the accreditation panels as part of the programmatic review process, which would not apply for the aligned model. Training for consistency and competency of panel members would be encouraged for the accreditation panel volunteers. The accreditation agenda would not change significantly. Agreement between the primary stakeholders to the processes, at a high level, is necessary for report generation, report sign-off, to agree communication and liaison between organisations, to allow publication of the accreditation reports, minimise confidentiality and data protection concerns and provide consistency in report conditions and recommendations. Two reports will be generated for the aligned/linked processes. One report per programme would be prepared during the accreditation process, agreed by the Engineers Ireland accreditation board and added as an annex to the programmatic review process. The addition of an appeals process for the accreditation decision would be welcome. There would be two independent outcomes of validation and accreditation. Accreditation would continue to be exclusively decided by Engineers Ireland and validation would be decided by the relevant HEI.

The accreditation processes of other engineering and construction professional associations would be affected in a similar manner to the Engineers Ireland accreditation process so most of the implications would also apply. Mapping of the professional association accreditation processes to the programmatic review process would be necessary to identify the unique parts of the process and consequently the scale of the reduction of the programmatic review process in the linked scenario. The aligned process would not alter but the timing constraints could prove challenging. Some of the professional associations have expressed interest in bringing their accreditation processes into closer alignment with the programmatic review process. Their gatekeeper roles would be maintained and they would continue to manage their own processes. The Engineers Ireland evidence review could be promoted as a beneficial assessment of engineering programmes. International partnerships should not be affected and their influence on the programmatic review process could increase. The creation of one set of validation and accreditation objectives should be possible.

The accreditation processes of professional associations outside of engineering and construction would be affected in the same way as accreditation processes of other engineering and construction professional associations and the same implications will apply.

8.5.3 Implications for Policy and Policy Makers

The implications for policy and policy makers will be considered in terms of their possible effects on policy, the HEI's designated awarding body status, Engineers Ireland accreditation agency status, the role of QQI and the role of government and its education agencies. The programmatic review and Engineers Ireland accreditation processes have different drivers, biases and motivations.

Programmatic review policy has traditionally been defined by QQI and adopted by HEI academic councils. QQI's Core Statutory Quality Assurance Guidelines define programmatic review (QQI, 2016). Each HEI's academic council has developed its own quality assurance procedures/guidelines for programmatic review. All institutes of technology became designated awarding bodies in January 2020 and can make their own awards for programmes from level 6 to level 9 on the NFQ. With the new designation to awarding bodies, the HEIs have the freedom to re-arrange their internal quality assurance processes. However, most HEIs have adopted the QQI quality assurance standards to date. The title 'programmatic review' may change but it is unlikely that this internal quality assurance process will change significantly from current practice. The aligned/linked processes could reduce the content of the programmatic review process in the programmatic review event but it would be captured in the Engineers Ireland accreditation process. Strategic reflection in the programmatic review process will be retained. The programmatic review policy/guidelines may need to be amended to reflect that an external accreditation agency may contribute, through their accreditation process/reports, to the programmatic review process. Validation remains the responsibility of the HEI.

The Engineers Ireland accreditation policy is set out in the Accreditation Criteria for Professional Titles document (Engineers Ireland, 2014) and the accreditation procedure in the Procedure for Accreditation of Engineering Education Programmes document (Engineers Ireland, 2015). These policy documents have been accepted for international mutual recognition agreements. The aligned/linked process will not alter the content of the policy documents but they should be amended to recognise the contribution of the accreditation process to the programmatic review process and how changes to accreditation criteria may be reflected in changes to the programmatic review process. The evidence review for the assessment of engineering programmes will be retained. Accreditation remains the responsibility of the professional association.

As well as the implications for HEIs set out in section 8.5.1 of this chapter, HEI academic council's role will be expanded to accept the accreditation reports as contributing to their programmatic review process in the linked option. The primary stakeholder and gatekeeper role for validation will continue. International influences and decisions from the European Union will impact on the validation process. A high-level agreement with the professional association(s) should be established to determine the authority and the responsibilities of all stakeholders. The challenge of reporting to many masters for accreditation of engineering programmes in HEI schools of engineering remains. Creating and agreeing one set of validation and accreditation objectives for both quality assurance processes would be welcome.

As well as the implications for Engineers Ireland set out in section 8.5.2 of this chapter, Engineers Ireland policy and procedures are approved by the Engineers Ireland Executive Committee and Council. The primary stakeholder and gatekeeper role for accreditation will continue. Communication and liaison with HEIs will be critical to the success of the linked and aligned options.

Designated awarding bodies (HEIs) should include their awards on the NFQ and co-operate and consult with QQI, who retains their overseeing role of quality in higher education. The range of professional associations involved with higher education and their accreditation processes have been identified by QQI, who are seeking to have closer working relationships with them. QQI emphasised the importance of bringing the validation (engineering award standards) and accreditation objectives into closer alignment. Inclusion of QQI in the high-level agreement between HEIs and the professional institutions would be helpful around the synchronisation of review cycles, creating a single set of objectives and other process details.

Government, through its education departments/authorities (Department of Education and Skills, the Higher Education Authority (HEA), and the Technological Higher Education Association (THEA)) influence policy formation and implementation. The validation role of HEIs stems from government commitment to quality in higher education. HEIs are financed by the education authorities and this allows HEIs to fund the programmatic review and accreditation processes. Inclusion of the HEA and THEA in the agreement between stakeholders would allow these processes to continue and ensure that the arrangements were considered in any future education authority policies.

8.5.4 Implications for Engineering Practice

The implications for engineering practice will be considered in terms of engineering employers, the engineering profession and the impact of engineering on the public.

Engineering employers expect engineering programmes to be accredited. Graduates find employment in engineering organisations easier when they have engineering qualifications that are accredited by the relevant professional association. This is particularly true for civil engineers, who must have chartered engineering status to perform some roles. The relevance of engineering accreditation for other fields of engineering is less obvious. Engineering employers also encourage graduates of accredited programmes to continue to gain a higher level of professional title. Engineering employers are asked to participate on programmatic review and accreditation panels. The volume of documentation can be discouraging for programmatic review industry panel members but the shorter process may assist. The request for employer participation on panels should be once every five years rather than on two occasions, which will further reduce the workload for industry panel members. However, the timely contribution to accreditation reports by industry panel members will be more critical in the linked process. Engineering employers may be asked to be interviewed by the review panels for both processes but the frequency would be reduced in the aligned/linked process.

The engineering profession expects engineering programmes to be accredited. With a linked process the engineering profession would have a closer connection to the HEI academic quality framework. The high-level agreement between the stakeholders would place the engineering profession, through Engineers Ireland, into the realm of higher education quality assurance. The civil engineering profession have a long history in supporting staff to become chartered engineers so that they can fulfil specific positions in their industry. It is noteworthy that the civil engineering participants were advocating for mandatory accreditation and the mechanical/electrical engineering participants sought voluntary accreditation as the relevance of accreditation for the civil engineering industry is more serious. The engineering profession would retain exclusivity of the accreditation decision.

If the recommendations arising from this research are implemented, the wider public would have engineers who are qualified both academically and professionally. The bringing together of academia and the engineering profession, by agreement, would be an outcome of an aligned/linked process. Engineering programme accreditation encourages graduates to pursue higher professional titles of chartered engineer or fellow status.

8.6 Conclusion

Chapter eight provides the researcher's interpretation and discussion of the research findings for the two major quality assurance processes of engineering education. This research study has provided evidence that there is a strong desire and willingness to bring the external accreditation process into closer alignment with the internal programmatic review process. The research has identified a variety of participant perspectives on an appropriate method of combining/aligning the processes.

The research findings for each of the nine research objectives was considered sequentially. Evidence from the research findings was used to address the research objectives, and the meaning of the answer was explained, together with any alternative explanations. The findings were critically examined in light of the literature and recent similar studies to determine whether they supported or differed in outcome or approach. Reference to relevant appendices and tables in chapters five, six and seven were provided to enhance the conclusion. Findings were connected to their effect on engineering practice. The application of the research findings to other contexts was mentioned, where appropriate. Distinctions and trends between participant group type responses and engineering discipline responses were stated. Identification of the relationship between participant consensus and research outcomes were noted.

The main unexpected findings in the research were outlined in terms of the changing higher education landscape, the Engineers Ireland accreditation process variations and individual unexpected findings. The research limitations were discussed in terms of the scope of the research, limitations due to the methodology used in the research design and limitations due to the researcher. The reasons why the limitations arose and why they could not be included in the research design were examined together with proposals for future research studies.

The primary implications for the research outcomes were discussed under the headings of engineering education, professional associations, policy and policy makers and engineering practice. The implications for engineering programmes, HEIs, management and academic staff, students, graduates, Engineers Ireland, other professional bodies, programmatic review and accreditation policy, QQI, government and education agencies, engineering employers, the engineering profession and the general public were considered and evaluated under those headings.

Three options to bringing the programmatic review and Engineers Ireland accreditation processes into closer alignment have been identified by this research study as:

- Linked process;
- Aligned process with accreditation prior to the programmatic review process;
- Aligned process with accreditation after the programmatic review process.

Implementation of any of these options will require the removal of the major roadblocks shown in table 8.1.

Closer Alignment Mechanism	Achievable	Achievable	Roadblock
	Yes	**No**	
Combined Processes		No	Statutory Authority and Responsibilities
Linked Processes	Yes		High level agreement between the primary stakeholders. Maintaining of gatekeeper role and responsibilities.
Aligned Processes – Prior to Programmatic Review	Yes		High level agreement between the primary stakeholders. Maintaining of gatekeeper role and responsibilities.
Aligned Processes – After Programmatic Review	Yes		High level agreement between the primary stakeholders. Maintaining of gatekeeper role and responsibilities.

Table 8.1: Roadblocks to Implementation of the Closer Alignment of the Quality Assurance Processes

The combined process is not considered to be achievable, but either a linked or aligned process may be achieved. In the latter option, the two components of programmatic review and Engineers Ireland accreditation can be carried out in either order. All the feasible options will have to overcomes the same roadblocks.

Chapter nine will reflect on this research study, particularly the research findings. Recommendations for future research will be given and repercussions of the findings for the primary stakeholders and policy will be considered.

Chapter 9: Conclusions and Recommendations

9.1 Overview

Chapter nine provides the conclusions and recommendations of this research study. This chapter summarises and reflects on the research undertaken, the research findings and the interpretations drawn from the research findings. The implications for policy and primary stakeholders are reviewed. Recommendations for future research studies are provided.

Chapter one introduces the programmatic review and accreditation processes in engineering education. The emergence of engineering education in Ireland and the United Kingdom, and the programmatic review process, together with the emergence of the engineering professional bodies, in both jurisdictions, and their accreditation processes are described in chapter two. Chapters three and four discuss the research design development and implementation from theoretical and practical perspectives. The research findings are given in chapters five, six and seven and chapter eight discusses their repercussions for the two major quality assurance processes of engineering education.

The content of this chapter is organised into five streams and addresses the research question and each of the nine research objectives based on the research findings, summarises and contemplates on the research, makes recommendations for future research, considers the originality of the research and its contribution to knowledge and concludes with a summary of the outcomes from the research. Reflection within a stream involved a number of stages, in most instances.

A summary of the research, the responses to the research question and the achievement of the research objectives are considered in stream two emphasising how the objectives were met in the research. Stream three explores the effectiveness of the methodology in answering the research question and the significance and implications of the research findings. Recommendations for future research studies are posed in stream four. Stream five outlines the originality of the research and how it contributes to knowledge. The chapter concludes with a summary of the research outcomes and the contribution of the research to the programmatic review and Engineers Ireland accreditation processes.

9.2 Response to the Research Question and Objectives Based on the Research Findings

9.2.1 Summary of the Research

The introduction chapter set out the context of the research by introducing the programmatic review and accreditation processes, framed the research question and objectives and outlined the structure of this thesis. Situating the quality assurance processes within the higher education quality framework, and exploring their effect on the quantity of review activity, highlighted the desire by HEIs to bring the processes into closer alignment.

The literature review chapter outlined the emergence of quality policy development within the Irish higher education system and the development of engineering education in Ireland and the United Kingdom. The emergence of government education agencies to oversee quality in HEIs and the appearance of engineering graduate attributes in recent years has influenced curriculum development for engineering programmes. Engineering professional associations evolved from small beginnings into national organisations in both jurisdictions and led the development of accreditation of engineering degrees. National and international influences have shaped the engineering accreditation processes over time. The nett outcome is that there are two major quality assurance processes for engineering education programmes known as programmatic review (validation) and accreditation.

The research methodology chapter considered the philosophical basis of the research design and endeavoured to highlight the reasons behind the choice of research paradigm, ontology, epistemology, axiology and research methods for data collection and analysis. The theoretical framework for this research adopts a pragmatic paradigm, a subjective ontology with multiple realities, an interpretivist epistemology and axiology and constructivist grounded theory and the Delphi technique for data collection and analysis.

The research design emerged after consultation with gatekeepers and stakeholders from HEI staff and professional association representatives through to QQI. Focus groups, THEA Councils and research supervisors' meetings generated the initial questions for the research. The research implementation plan included the application for ethical approval from UL and LIT, the identification of participants, conducting the Delphi technique round one semi-structured interviews, sending a questionnaire to participants for round two and holding semi-structured interviews for round three. The rounds one and two outcomes were fed back to the participants before the next round commenced. Considerations of validity and reliability were a cornerstone of the research design.

Chapters five, six and seven described the research findings that emerged from the three data collection rounds. The data was then analysed, using the pertinent techniques appropriate to the data collected, to ensure that emergent themes were exposed and all data was retained. This culminated in narrative summaries for each of the three rounds of data collection where each theme was examined in terms of frequency of occurrence, participant group type and engineering discipline. The number of participants who disagreed with each theme was also noted together with any suggestions made by participants.

The research findings were discussed in chapter eight. The findings are debated in relation to the research question and objectives with reference to the literature and effect on practice. Unexpected findings were mentioned. Limitations of the research are described together with their impact on the interpretation of the findings. Reflection on the implications of the research findings for engineering programmes, HEI academic staff and management, professional associations and other stakeholders was provided. The thesis concludes with an overview of the research and reflection on the research findings. Recommendations for future research studies are put forward. The originality of the research and how it contributes to knowledge is considered followed by the research conclusion.

9.2.2 Research Question

The research question for this study is '*How can the external accreditation process of engineering education programmes in Ireland be brought into closer alignment with the internal quality assurance programmatic review process of these programmes?'*

Based on qualitative and quantitative analysis of the research participants' perspectives on the quality assurance processes in engineering education, it can be concluded that the external accreditation process of engineering education programmes in Ireland can be brought into closer alignment with the internal programmatic review process in institutes of technology. The results indicate that combining the processes into a single quality assurance process is unrealistic to achieve based on the factors of statutory authority and responsibility vested in HEIs and Engineers Ireland and their gatekeeper roles to the engineering profession. The research clearly illustrates that aligning or linking the processes can be achieved. Critical factors to consider when aligning/linking the processes include responsibility, decision making and communication. Research participant consensus was not reached on the method of combination/alignment of the processes.

9.2.3 Research Objectives

Research objective one for this study is '*to probe the willingness of stakeholders to engage with the concept of bringing the quality assurance processes into closer alignment.*' The research findings testify that there is a strong desire and willingness, by the stakeholders, to bring the quality assurance processes into closer alignment. The participants envisage greater alignment between academic and professional education but recognise that the policy driven processes have different drivers, outcomes and international influencers. The literature supports and agrees with this outcome as does the consensus reached by the research participants. It is noteworthy that participants acknowledge and applaud the positive contribution that programmatic review and accreditation have made to the quality of engineering education programmes.

Research objective two for this study is '*to identify and critically appraise the advantages, disadvantages and barriers to bringing the engineering education programmatic review and accreditation processes into closer alignment.'* The research findings describe the advantages, disadvantages and barriers to combining/aligning the quality assurance processes and they are mentioned consistently throughout all the Delphi rounds of data collection. The participants have reached consensus on the identified advantages, disadvantages and barriers.

Research objective three for this study is *'to explore and appraise the power, responsibilities and influence of the main stakeholders to the quality assurance processes for engineering education.'* Based on the research findings, the consensus reached by the participants, the researcher's experience and the literature, it can be concluded that the authority, power, responsibilities and influences of the primary stakeholders to the engineering education quality assurance processes determine how the policies and quality assurance processes are perceived, formulated and implemented. The research demonstrates that neither HEIs nor Engineers Ireland can cede their statutory authority and responsibility to another party. The findings signal that the HEI's academic council and the Engineers Ireland's accreditation board can only accept their own areas of responsibility and approvals. A high-level agreement between the education providers and professional association(s) is likely to be required for the aligned/linked process options for responsibility, communication, decision-making and report sign-off.

Research objective four of this study is '*to identify the most appropriate method of combination/alignment of the processes and to examine if the internal programmatic review process can be enhanced by using the evidence-based methodology of the Engineers Ireland accreditation process.'* The results indicate that combining the processes into a single quality assurance process is unrealistic to achieve based on the factors of statutory authority and responsibility vested in HEIs and Engineers Ireland and their gatekeeper roles to the engineering profession. The research clearly illustrates that aligning or linking the processes can be achieved. Linked/aligned accreditation and programmatic review processes would allow the statutory authorities to conduct their review of engineering programmes, maintain their gatekeeper role, minimise duplication of effort and maximise efficiencies. Analysis of participant responses suggests that the order of preference of the options available would be (1) a linked process, (2) an aligned process (accreditation prior to programmatic review) and (3) an aligned process (accreditation follows programmatic review).

Research objective five for this study is '*to investigate if the Engineers Ireland accreditation process should be voluntary or mandatory when the processes are in closer alignment*.' The research results provide evidence that the majority of participants agree that the accreditation process should remain voluntary, but there is no consensus on whether the accreditation process should be voluntary or mandatory. It is worth noting that no other professional association in the engineering and construction disciplines in Ireland has mandatory accreditation. The research findings imply that the accreditation process should remain voluntary and it should be the HEI's choice to request the relevant professional association(s) to accredit its programmes.

Research objective six for this study is '*to determine and appraise the most suitable synchronisation of the review cycles and changes to the site visit agenda(s) of the programmatic review and accreditation processes to facilitate closer alignment*.' The research findings clearly show that a five yearly review cycle for both accreditation and programmatic review would facilitate closer alignment of the processes. An interim review may be needed for technology areas where five years is too long (information technology awards). An aligned or linked process should not require changes to the accreditation site visit agenda. An aligned process should not require changes to the existing programmatic review site visit agenda, but a linked process would reduce substantially the complexity and length of the site visit.

Research objective seven for this study is '*to explore and critically evaluate the possibility that the validation and accreditation objectives can converge into a single set of objectives to support the alignment/combination of the quality assurance processes*.' The research results indicate that the QQI engineering award standards and the Engineers Ireland accreditation criteria need to be aligned in terms of objectives and programme outcomes. Similarities in the objectives has created duplication and overlaps within the processes. Triangulation by the researcher of the Engineers Ireland accreditation criteria, the QQI professional award type descriptors and the QQI engineering award standards has established that the three sets of standards/criteria are already very closely aligned. The existing validation and accreditation objectives could be reconfigured into one set of objectives. Programme outcomes for both processes could be agreed between the Engineers Ireland's accreditation board and the HEI's academic councils.

Research objective eight for this study is '*to identify and scrutinise how communication and liaison can be managed between stakeholders and organisations for the revised process(es).*' The research findings strongly signal that communication and liaison between organisations should be agreed in a high-level protocol and be managed between the Engineers Ireland Registrar and the HEI's Dean/Head of School of Engineering in consultation with the HEI's Registrar and the engineering Heads of Department.

The constitution of the programmatic review panel could include a mix of academic members, engineering employers, Engineers Ireland representatives and international members. The accreditation panel of three members per programme could continue to allow an adequate assessment of the programme evidence for both aligned and linked processes. The aligned process would have fully separate panels but the linked process could have separate or connected panels. Competency and training of panel members is a consistent and pervasive message in the research. Training should be encouraged for all panel members to ensure adherence to quality assurance processes.

For the linked process, two reports within the same timeframe are generated, where the accreditation report is approved by the accreditation board and added, in a separate section, to the programmatic review report to minimise confidentiality and data protection concerns. The two reports remain independent in the aligned process. An appeals procedure could be added to the accreditation process.

Research objective nine for this study is '*to evaluate and investigate if validation and accreditation should remain independent outcomes.'* The research results clearly suggest that validation and accreditation should remain as independent outcomes as they are two separate decisions. This finding is supportive of the aligned and linked process options.

9.3 Reflection on the Research

The effectiveness of the methodology used in answering the research question and the significance and implications of the research findings are presented in this stream of the chapter.

9.3.1 Effectiveness of the Methodology in Answering the Research Question/Objectives

Incorporation of a consultation phase at the start of the research design enhanced the Delphi technique as it broadened the range of participants who contributed to the study. Insights contributed by the THEA Council of Heads of School of Engineering, the THEA Council of Registrars, the Registrar of Engineers Ireland, HEI staff and QQI focused the research question and objectives on the likely areas of contention to bringing the quality assurance processes into closer alignment from the beginning of the research. The methodological and other limitations of this research study are provided in stream 8.4 of this thesis. The Delphi technique has achieved participant consensus in all but three of the research themes, so was very effective in answering the research question. While comparing programmatic review with the Engineers Ireland accreditation process limits the generalisability of the results, this approach has enabled three possible ways to bring the processes into closer alignment to emerge from the research findings.

9.3.2 Significance and Implications of the Research Findings

The research findings conclude that the external accreditation process of engineering education programmes in Ireland can be brought into closer alignment with the internal programmatic review process in institutes of technology. The findings indicate that it is not plausible that the processes can be combined into a single quality assurance process but the results clearly illustrate that aligning or linking the processes can be achieved.

A linked or aligned accreditation/programmatic review process would allow the statutory authorities to conduct their review of engineering programmes, maintain their gatekeeper role, minimise duplication of effort and maximise efficiencies. Three options proposed for the aligned/linked model could be a linked process, an aligned process (accreditation prior to programmatic review) and an aligned process (accreditation follows programmatic review). All three options would require willingness by the stakeholders and gatekeepers to agree a high-level protocol to identify and manage authority, responsibility, communication, decision-making and report approvals.

The primary implications for the research outcomes have been discussed in relation to engineering education, professional associations, policy and policymakers and engineering practice in stream 8.5 of this thesis and are considered for the aligned/linked processes.

Engineering education programmes could be reviewed academically and professionally in the same timeframe. Reinventing the reduced programmatic review process will require mapping of the processes for the linked option but no change is envisaged for the aligned option. The Engineers Ireland process should not change when aligning or linking the processes. Voluntary accreditation, a review cycle of five years and the submission of a single document per programme would apply to both options. One set of validation and accreditation objectives would support the connection of the processes. Accreditation reports could be signed-off by the accreditation board and then added to the programmatic review report but the validation would remain the decision of the HEI's academic council. The HEI will continue to be a major stakeholder and gatekeeper to the engineering profession. The linked model would lead to a less complex programmatic review process but the agenda and timing of reviews with Engineers Ireland becomes more critical. Composition of review panels may not change for either option but training of panel members is envisaged. Communication should be managed between the Engineers Ireland Registrar and the Dean/Head of School of Engineering. Students and graduates' contributions to the processes remain.

Engineers Ireland will continue to be a primary stakeholder and gatekeeper to the engineering profession. The accreditation process should not change for the aligned or linked scenario but the influence of the process will increase in the linked option. The timing of accreditation to connect within the same timeframe as the programmatic review process could be challenging to achieve.

Voluntary accreditation, review cycle of five years and the site visit agenda will continue for the aligned/linked options and support Engineers Ireland's compliance with international agreements. The evidence review of engineering programmes should be accepted by the HEI's academic council as the programmatic review assessment of the programmes in the linked model. One set of documentation will allow the accreditation panels to have sight of programme statistics. Staffing and training of accreditation panels is likely to continue to be a concern but the composition of the panel should not change. One accreditation report per programme could be agreed by the accreditation board and included in the programmatic review report for the linked option. Accreditation would continue to be exclusively decided by Engineers Ireland. The same implications would apply to other professional associations including the mapping to the programmatic review process.

The programmatic review policy/guidelines may need to be amended to reflect the contribution of the accreditation process to the programmatic review process in the linked scenario. Likewise, the accreditation policy could be altered to agree the use of the accreditation report, and its findings, in the programmatic review process. The academic council's role may be expanded to accept the accreditation reports as contributing to their programmatic review process in the linked model. Communication and liaison will be critical to the success of both options. QQI, the HEA and THEA need to be aware of any agreement between the HEIs and professional associations concerning quality assurance of engineering higher education programmes.

Engineering employers and the engineering profession expect engineering programmes to be accredited and they participate in the processes as panel members or to be interviewed by panel members. The frequency of contribution to the processes should reduce for the three aligned/linked scenarios. Accreditation is relevant for civil engineers in the performance of their duties, perhaps more so than the other disciplines of engineering. Engineering employers encourage graduates of accredited programmes to seek professional titles. With a linked process, the engineering profession would have a closer connection to the HEI's academic quality framework. The bringing together of academia and the engineering profession, by agreement, could be an outcome of the aligned or linked processes.

9.4 Recommendations for Future Research Studies

Recommendations for future research studies could address aspects of the research limitations, expand the research boundaries, explore the unexpected findings and further investigate the themes where consensus was not reached. These recommendations are intended to build on, or enrich, the research findings from this study, and are as follows:

- Map the accreditation processes of other engineering and construction professional associations to the HEI's internal quality assurance process to create specific linked processes for each professional association;
- Map the accreditation process of the professional associations outside of the engineering and construction field to the HEI's internal quality assurance process;
- Determine if it is feasible to link the universities' quality assurance processes to the Engineers Ireland accreditation process;
- Establish whether a link between HEIs' internal quality assurance processes and their engineering professional associations in ENAEE/IEA member jurisdictions is feasible;
- Explore the difference in attitudes of participants across the three main engineering disciplines (civil, mechanical, electrical) to the accreditation of engineering programmes in relation to aligning/linking the processes;
- Examine the appropriateness of the accreditation process for engineering and construction programmes being voluntary or mandatory across a range of professional associations;
- Investigate the relationship of accreditation objectives to the relevant discipline quality assurance standards. Determine if the accreditation objectives and validation standards can become one set of objectives and programme outcomes;
- Address the benefits to employers and students of having an engineering qualification that is academically and professionally assessed;
- Investigate if a larger portion of time for the questionnaire data collection rounds of future studies involving the Delphi technique is appropriate;
- Investigate alternative methods of bringing the processes into closer alignment, other than combining or aligning the existing quality assurance processes. Alternative methods could include a continual audit approach, expansion of the external examiner role, use of trained panel chairs for a limited time period or annual reporting to Engineers Ireland;

- Scrutinise how digital technology may be utilised for document preparation, evidence gathering, evidence storage, evidence display, report generation and report sign-off for both quality assurance processes and where the same information can be shared across the processes.

9.5 Originality and Contribution to Knowledge

9.5.1 Originality of the Research

Combining/aligning the programmatic review with the Engineers Ireland accreditation process had long been an ambition of the processes' stakeholders. Two participants mentioned that it was briefly discussed at an Engineers Ireland Annual Conference in the eighties/nineties and the decision, at that time, was to keep the processes separate. Some universities have created accreditation policies to pave the way to align the programmatic review and accreditation processes (PARN, 2017). Dublin City University is an example of one such endeavour in the engineering field. This research, exploring the feasibility of combining or aligning the two quality assurance processes, is the first study to investigate the possibility of, and mechanism of, combining/aligning the processes in Ireland.

The three options, identified in the research findings, to align/link the processes have not been implemented previously in the proposed form. Engineers Ireland representatives have participated on programmatic review panels in the past, in a few HEIs, and reported back to the Engineers Ireland accreditation board. These arrangements have been temporary and independent to individual HEIs. This research study proposes a sector wide approach which is consistently applied across all the institutes of technology/ technological universities.

Aligning Engineers Ireland's accreditation before the programmatic review process is an approach which was supported by the participants. Most participants assume that the accreditation process would occur after the programmatic review process because the programme evaluation is normally assessed towards the end of the site visit. The evidence reviews and other components of the accreditation process would be better placed to feed into the programmatic review process and this is supported by the findings of the PARN and Engineers Ireland Accreditation Review reports, as discussed in chapter eight of this thesis (PARN, 2017), (Engineers Ireland, 2019). An original feature of this research is the proposal to align the accreditation process before the programmatic review process.

The linked process concept is an original approach to bringing the processes into closer alignment which was not mentioned by any of the research participants. This was clearly a desire by participants to combine the two processes into one process but statutory obligations and gatekeeper functions inhibit that possibility. Based on participants’ views and comments expressed during the interviews, the linked option was created to intertwine the processes to create maximum efficiencies and reduce duplication.

One of the unknowns at the commencement of this research was how closely the Engineers Ireland accreditation criteria matched the QQI engineering and professional standards. The triangulation of the three standards/criteria carried out in the consultation phase of the study determined that the processes were over 90% aligned, although expressed in different, but similar, language. The comparison across these standards is a new insight emanating from this research study.

The originality of the research is also seen in practical terms. To frame the research in the appropriate context, the researcher commenced the study with significant consultation with the stakeholders. One of the outcomes to this unconventional approach to the Delphi study resulted in the researcher bringing QQI and Engineers Ireland into a closer working relationship with the prospect of continuing interaction and regular meetings.

9.5.2 Contribution to Knowledge

Investigating the means of bringing the programmatic review and the Engineers Ireland accreditation processes into closer alignment has produced a greater understanding of the gatekeeper and statutory roles of the stakeholders and, for the first time, generated specific knowledge particular to how a sector wide approach can be used to align/link the processes. This approach is consistent with the sector wide programmatic review process and national Engineers Ireland accreditation policy and procedures (QQI, 2018), (Engineers Ireland, 2014). Patil and Codner (2007) consider that quality assurance in engineering education is internal (HEI), external (professional associations), national (QQI, THEA) and international (IEA, ENAEE). Nevertheless, international multi-national accords and mutual recognition agreements have influenced the design and quality assurance of engineering programmes globally (IEA, 1989), (IEA, 2008). This study confirms the findings of the PARN report where suggestions for streamlining and reducing duplication of the processes are explored at national level, but differs by focusing on the institute of technology sector (PARN, 2017).

The research contributes to the growing body of knowledge in the field of quality assurance processes in engineering higher education by the identification of three aligned/linked processes to bring the programmatic review and Engineers Ireland accreditation processes into closer alignment. Attention needs to be paid to the timing of the site visits, communication and decision-making protocols, synchronisation of the review cycles, responsibility of stakeholders and report approvals. This study confirms the findings of the PARN report which recommends '*the integration and streamlining of systems'* but extends the body of knowledge by the identification of how this streamlining may be achieved (PARN, 2017). Similarly, this study extends the body of knowledge of the Engineers Ireland Accreditation Review report '*to link/align the accreditation process in some way with the programmatic review process'* by presenting three options as to how this ambition can be realised (Engineers Ireland, 2019). This study extends the proposal in the Quality in Higher Education 2020 report to '*dovetail processes and reduce the burden of accreditation on HEIs*' by providing options to make the proposal attainable (QQI, 2019).

This study is significant because it extended the existing body of knowledge by comparing across the QQI engineering and professional standards and Engineers Ireland accreditation criteria. The PARN report recommended further research on the differences in quality assurance objectives and interactions between professional bodies (PARN, 2017). This study extends this knowledge by providing detailed comparison across the QQI standards and Engineers Ireland accreditation criteria and is consistent with the drive to '*align professional standards and the learning outcome requirements of the Higher Education Standards Framework of Australia'* expressed in the Joint Statement of Principles for Professional Accreditation document (Universities Australia and Professions Australia, 2016).

The findings of this study have both a theoretical and applicative emphasis. The theoretical contribution is understanding the role of the processes, the relationship between the stakeholders and their impact on engineering education. The applicative nature of the research findings has highlighted the need for a high-level agreement between the education providers and professional association(s). This outcome from the research study confirms the finding in the PARN report which suggests that '*Communication between the HEI and the professional association is key*' (PARN, 2017) and the finding in the Engineers Ireland Accreditation Review report that '*the processes should be synchronised*' (Engineers Ireland, 2019) but also provides comprehensive implications for stakeholders and policy.

Early consultation with stakeholders of both processes culminated in the 'Concerns and Challenges of Incorporating the Accreditation Process into the Programmatic Review Process' document and the 'Comparative Analysis of the Programmatic Review and Accreditation Process' document which were agreed by the stakeholders. Both documents contribute to new knowledge, generated by the researcher in collaboration with the stakeholders. This new knowledge confirms and significantly extends the findings in the PARN report '*that periodic academic revalidation of programmes is a significant resource demand in addition to the professional accreditation processes'* (PARN, 2017).

Engineers Ireland are currently updating their accreditation criteria and their accreditation procedures. Engineers Ireland, through the Registrar's office, has expressed a desire to utilise the outcomes of this research study to feed into the revisions to their accreditation procedures and thus impact the implementation of the accreditation process. This knowledge confirms the PARN report comment that '*professional association accreditation requirements appear to change with regularity*' (PARN, 2017) and the QQI Insights report comment that '*many of the professional associations are updating standards on a regular basis'*(QQI, 2019).

9.6 Conclusion and Overall Research Outcomes

Conclusions and recommendations for the research study are given in this chapter. Based on the research findings, responses were provided for the research question and each of the nine research objectives, highlighting how the findings met the research question and objectives.

An overview of the research design, its implementation, the findings, analysis and the outcomes explore the success of the Delphi technique for data collection in answering the research question. The ramifications of the research findings for all the stakeholders are summarised and recommendations for future research outlined.

The originality of the research and how it contributes to knowledge are discussed in respect of combining/aligning the programmatic review and Engineers Ireland accreditation processes as a sector wide undertaking, the innovative three options for aligning/linking the processes, the triangulation of the QQI engineering and professional standards and the Engineers Ireland accreditation criteria, the significance of the consultation with stakeholders and gatekeepers at the start of the research and the possible impact of the outcomes of this research study on the Engineers Ireland accreditation procedures.

This research had yielded insights and conclusions that are linked to practice and theory to illustrate originality. This modest contribution to knowledge is a work in progress, in a field that is constantly evolving, developing and changing. In this way the researcher hopes her research contribution is influential in bringing the processes into closer alignment.

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