Opportunities Available

Towards a Digital Skills Action Plan for Northern Ireland

September 2019

Innovation

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Executive Summary

Digital skills are increasingly demanded throughout the economy

The Northern Ireland economy has experienced a stable economic recovery since the global financial crisis a decade ago. In particular, the *Information & Communication* sector has seen spectacular growth over this period—with the number of computer programming and consultancy companies more than doubling, the number of foreign direct investment companies established in Northern Ireland more than doubling, and an expansion of employment in the sector by over 7,000 people.

The sensational growth in demand for individuals with digital skills has not only been seen in the Information & Communication sector. The progressive digitisation of goods production and service provision has led to the demand increasing throughout the Northern Ireland economy. From agri-food to manufacturing and from financial services to tourism, the demand for digital skills is becoming increasingly ubiquitous.

The increased demand has not been met with adequate supply

The growth in demand for digital skills, in terms of employee replacement and firm expansion, has not been met with the adequate level of supply in the market. Over the past six years the number of advanced digital skills—defined in terms of RFQ Level 6+ education—entering the labour market has diminished. At the same time, the demand for these skills has been increasing. This has led to a significant skills gap that is constraining business and economic growth. **Broadening our scope beyond the Information & Communication sector to look at the digital economy as a whole; we find that the skills gap in, broadly speaking, computer science and related technical subjects is approximately 325 people per year.**

This report finds that the current market for digital skills is overheated, reflected in economic indicators such as inflated wage levels and labour turnover—particularly for more experienced roles. Industry has experienced issues in the attraction and retention of individuals with relevant skills and qualifications, significant barriers to entry for small and entrepreneurial companies, increased pressure from competition for labour in Ireland and London, and an overall loss in productivity and competitiveness.

A significant skills gap has emerged

As a result, the skills gap has been reflected in eighty-six percent (86%) of software-oriented firms experiencing significant difficultly in hiring appropriate skills at required levels of experience and competence, with ninety-five percent (95%) seeking to increase their demand for digital skills in the foreseeable future.

Note that this is a people *and* skills issue. Not only is there a shortfall in the number of qualified people currently in the market in Northern Ireland, but there is also a reported mismatch in the skills taught at higher and further education, particularly in areas such as cloud computing and data analytics. Importantly, the sheer lack in the supply of people is the most significant for many companies. However, it is felt that the skills being taught at higher and further education has continued to lag what the industry needs.

Importantly, this is a phenomenon that is not unique to Northern Ireland. All regions across the UK are currently experiencing digital skills issues. Typically, it can be a symptom of the economy's own success. Industry in Northern Ireland feel that, due to the size of the economy and the fact that skills and education are both devolved, it is in a unique position to tackle the skills gap.

Developing an Action Plan to build on the success of the past

On 28th June 2012, the Department for Employment and Learning published the ICT Action Plan for Northern Ireland. This set out several policies targeted to three main areas: sector attractiveness, skills provision, and communication. Statistical evidence suggests that the policies pursued by this Action Plan worked—boosting the number of students accepting places in Computer Science and related fields in 2013, establishing the framework for higher-level apprenticeships and stimulating sector attractiveness with the introduction of the *Bring IT On* initiative.

When the Department for Employment and Learning separated into the Department for the Economy and the Department of Education, the ICT Action Plan fell between the stools. Until recently there have been few official publications that analyse the labour market for IT workers and digital skills in Northern Ireland. At the same time, there has been significant interest in the digital economy in terms of investment and government policy and a significant drop-off on the reach of Bring IT On; particularly in terms of employer backing it.

Several forums, working groups, and communication channels exist within the sector and with educational and government stakeholders. However, there is an industry-wide feeling of a notable lack of coordination between parties and lethargy in policies being committed and addressed. This report seeks to bring industry-wide issues to the fore and, in the spirit of the previous ICT Action Plan, this report recommends a host of policies focusing on demand-side, supply-side and coordination issues.

Policy Recommendations

When discussing the issues with stakeholders and industry representatives it was felt that the following policy recommendations were of paramount importance.

Demand-side policies:

- Invest NI, the Department for the Economy and industry to meet twice annually regarding FDI strategy, investments, and the attraction in technology companies.
- The analysis on skills demanded by the IT industry to be updated, reviewed and published annually by the Department for the Economy.
- The CBI to provision an annual regional survey to its members and related companies to understand their digital skills demands and gaps.
- Industry must be adequately consulted with regards the strategic investment into the development of innovation clusters. Consideration must be made for the pipeline of digital skills and the overall long-run market consequences of investing heavily in technological sub-sectors.
- Educational institutions and industry to work with each other to better understand the skill sets that are required by industry, and what is taught at NFQ Level's 5 and 6.

Supply-side policies:

- The provision of financial support in the immediate term for postgraduate taught courses in computer science and relevant technical fields; specifically focussing on conversion courses and specialist programmes in cyber security, statistics, analytics, and artificial intelligence.
- Higher Education institutions to be advised that future funding is to be prioritised on opening more undergraduate places in computer science, software development, and related fields. Separate funding for resourcing to be seriously reviewed.
- Sub-group to be established to review higher-level apprenticeships uptake and address issues presented in Section 4.4 such as billable hours, perverse incentives, and provide more accessibility to smaller firms. Consider measures provided by the group such as, the subsidisation of wages for first year apprentices (particularly for those in SMEs) until they have gained enough experience to be billable or productive in the company, or to centralise first-year HLA study programmes.
- Incentivise those who are economically inactive, unemployed, or those currently in a job to engage in distance-based learning programmes that teach digital skills. Incentivisation could come in the form of subsidising course fees for students unable to pay.
- Industry, with government support, to establish a centralised programme to streamline and harmonise graduate and apprentice on-boarding.
- The development of a Programme of Study for ICT education at Key Stage 3 level.

- Issue a call for further digital skills retraining / upskilling courses, targeting the unemployed and those wishing to return to the workforce after inactivity with flexible working opportunities.
- Department for the Economy to work with industry to identify why initiatives geared for sector attractiveness are not effective and what alternatives can be supported or established.
- Industry to work together on establishing a framework of best practices for effective work experience / shadowing and internships.
- Universities and colleges to work towards integrating at least one computer science module into teacher training courses.
- Industry along with schools and the Department of Education to facilitate increased continual personal development for teachers.
- Universities and colleges to share aggregate data regarding where Computer Science (or related) students work (company, industry, country) after graduating.
- Improvements in careers advice, work experience, and teacher upskilling in areas of computer science, mathematics, physics and engineering.

Cooperation and communication policies:

- Industry, educational stakeholders and government to consider a rationalisation of and removal of duplication in working groups and forums. A new structure of engagement must be considered that centralises communication.
- Advertising campaign to address young people and parents regarding career opportunities and pathways.
- Develop an online portal, like Tech/Life Ireland, that promotes opportunities and the attractiveness of living and working in Northern Ireland.

Immediate actions need to be taken

The people and skills mismatch are a burning platform that must be addressed. Six policies can be pursued immediately.

1. Provide funding for postgraduate courses focussed on conversion into computer science and specialist areas. Department for the Economy to ensure that increasing the intake of students into computer science and related fields at undergraduate level in HE institutions be of top priority when the institutions distribute their Maximum Student Number cap.
2. Department of Education to investigate developing a Programme of Study for Key Stage 3 level ICT and to better prepare and give confidence to post-primary teachers in this field.
3. Government and industry to agree to meet twice annually regarding the FDI strategy pursued in digital economy.

4. Sub-group to be established to review higher-level apprenticeships uptake and address issues given in this document.
5. Subsidise student fees for distance-based learning programmes that are targeted to economically inactive, unemployed, or those already in employment.
6. Industry to structure a harmonised onboarding process across the digital economy.

An Overview of Digital Skills and the Digital Economy

The supply of people and skills remains a top interest for all companies—from start-up to well-established and high growth—throughout Northern Ireland. A paramount concern lies in the inability to attract and retain individuals with technical skills associated with the support and development of technology.

The purpose of this report is to better understand the demand and supply of digital skills in the Northern Irish economy – the data and understanding provided throughout will inform policies and key performance indicators that address key mismatches or gaps between the demand and supply of skills. The ambition of which is to remove restrictive barriers to growth and provide a sustainable environment for all firms – from innovative start-ups to well-established Foreign Direct Investment (FDI).

Defining Digital Skills

In order to have a constructive discussion regarding digital skills we must first define what is meant by the digital economy and the skills that are used within it. Providing clarity regarding definitions is intended focus current and future discussion and anchor any debate regarding the provision of digital skills in the economy.

Typically, the concept of a digital skill is intertwined with the notion of *digital literacy*. Cornell University defines digital literacy as, “the ability to find, evaluate, utilize, share, and crease content using information technologies and the internet”. Given this broad definition, digital skills can be considered as any set of skills related to being digitally literate. Anything from being able to use word processing applications to be being able to programme mobile applications.

Specificity of digital skills

The definition of digital skills used throughout this report is stricter than what is implied by Cornell University. This report defines a digital skill as one *that can be taught in which an individual can use to productively contribute to the development, deployment, creation or distribution of a new or existing technology*. Examples of digital skills include the ability to:

- Write and utilise a programming language to contribute to the development of a product or service;
- Apply knowledge of new technologies to the design or development processes of an output;

- Use frameworks and processes to appropriately test software; and
- Deploy hardware or software locally or remotely.

Three digital skill categories

From discussions with technology companies it became apparent that three broad categories of individual with digital skills were demanded.

1. Generalists. Individuals who have general knowledge of technologies and their use. This is typically the most common role and can relate to recent graduates in technical areas.
2. Subject specialists. An individual with specific experience in a subject area such as, for example, artificial intelligence or digital marketing. Often requires some industry experience.
3. Domain / industry specialists. Individuals with advanced digital skills but also knowledge or experience within the industry in which the technology is supplied. For example, a software developer or data scientist for a financial institution with broader economics or finance education.

Note that subject and domain specialists have a significant and increasing demand in the market, though not as much as generalists which are widely demanded by large employers. Importantly, specialists are crucial for small and entrepreneurial firms that require specialist skills for initial product and service development. All categories of digital skill need to be supported and supplied to the market and the routes in which they are demanded need to be properly defined.

In all, this report considers relatively advanced levels of digital skills. As such, the definition of a digital skill implies that the individual has an exceptional level of digital literacy and can contribute directly to the *digital economy*.

Defining the Digital Economy

The traditional definition

When traditionally investigating the characteristics of the digital economy, economists and statisticians typically use the definition given by the broad *Information and Communication* industry group (industry code J). This industry group is far-reaching and includes publishing; broadcasting; telecommunications; information service activities; and computer programming, consultancy and related activities.

Although the industry group is widely encompassing, it does not fully encapsulate all areas of demand for digital skills. By taking the traditional view it is likely that the demand of digital skills would be significantly unrepresented relative to what is demanded in the economy as a whole. Consequently, policies generated from the analysis may be skewed and not reflective to the needs of the economy.

Taking a holistic perspective

Due to the progressive digitisation of goods production and service provision, each industry relies on some way on digital solutions. For example, financial institutions, accounting and legal firms, and auditing companies increasingly hire software engineers and data scientists to complement their traditional operations; however, these companies would not be included within the Information and Communication industry group. Likewise, construction and food and drink companies employ individuals with digital skills to improve communication or production processes. Again, this demand would not be considered. In light of this, this report takes a broader perspective regarding the digital economy than that of the traditional industry group.

In being as holistic as possible, we define the digital economy as *all economic activities directly focused on the production of new digital technologies, alteration or modification of existing digital technologies, and support of digital technologies throughout all industries*. At a practical level we consider all economic activity that is produced within relevant domains within the Information & Communication group, but also activities and other sectors that, in some way, produce and manipulate digital technologies either for their individual firm or the market.

Case Study 1. Beverage bottling company

This all-Island company is officially categorised in the manufacturing industry group (Section C), specifically as a manufacturer of soft drinks; production of mineral waters and other bottled waters (SIC code 11070). However, as a consequence of its size and vertical integration it has significant demand for individuals with specialist digital skills to develop technologies that assist production and improve productivity.

Case Study 2. Accounting and auditing company

This global company is primarily categorised in the financial and insurance activities group (Section K). Again, a significant and increasing number of individuals with general and specific digital skills are employed to assist operations throughout the organisation.

Case Study 3. Business organisation

An organisation that provides advice and professional services to other businesses. Increasingly this organisation is hiring individuals with digital skills to produce products and services that complement their offering.

This includes activities in non-traditional IT industry groups, such as those associated with financial and insurance activities; professional, scientific & technical activities;

water supply; electricity & energy; manufacturing; and wholesale & retail. Although much of this analysis places a heavy focus on the Information & Communication sector, we remain conscious of the demand and employment growth of individuals with digital skills and IT professionals throughout the Northern Irish economy as a whole.

Related measurements of the digital economy in Northern Ireland

Growth in the digital economy has become the driving force of a globally competitive economy, underpinning innovation, competitiveness and long-term prosperity. The size and output of the digital economy as defined above has not previously been measured. However, several reports have been written:

a. *Knowledge Economy Index Report (2019)[1], Catalyst Inc.*
   The most recent Knowledge Economy Index report, which has been published annually since 2011, analyses economic progress in the Knowledge Economy. The core sectors analysed include pharmaceuticals & biotechnology, medical devices, software, IT services, creative content, financial services, technology consultancy, aerospace and transportation, communications and computing and electronics.
   The report noted that during 2018 activity within the knowledge economy was the second fastest growing in the UK for the fifth consecutive year. They found that the Knowledge Economy directly employed 40,250 (4.7% of total employment) individuals with average wages of £28,000. Major focus on the report was based on skills provision, start-up activity and investment. On education and skills, they found that PhD investment and HEI grants remained at relatively low levels with the number of PhD students per million inhabitants ranked 10th out of all 12 UK regions.

b. *UK Tech on the Global Stage (2019), TechNation*
   The report showed that Belfast was now one of the best cities in the UK to work in technology – and the best place to come to work as a software developer. The report suggested that the digital technology sector in Belfast now employs 60,000 people, on salaries around 17% higher than the national average – around £40,000. According to TechNation, salaries had grown by 120% over the past four years.
   The report also found that Belfast was now one of five UK cities where more than 10% of people work in digital technology. Job opportunities in the sector were growing, with an increase of 16,853 roles being advertised in 2018.

[1] Johnson, R. (2019), "The 2018 Northern Ireland Knowledge Economy Report", Catalyst Inc. and Ulster University Economic Policy Centre

c. *Skills Demanded by the IT Sector (2019)[2], Department for the Economy*
This research bulletin provides an analysis of the demand for IT workers in Northern Ireland. The bulletin suggests that as the Northern Irish economy and jobs growth has increased over the past decade, businesses have increased their employment of IT workers. This demand for IT workers has been exacerbated by the digitisation of industries throughout the economy. The results suggest that as the demand has increased the supply has not caught up to meet it.

d. *Delivering Skills for the New Economy (2019)[3], CBI*
This report provides a survey-based analysis of digital skills shortages throughout the UK. It finds that UK-wide demand already outstrips supply, with over two-thirds of businesses reporting unfilled digital skills vacancies – and is set to increase. The majority of firms are fishing in the same pool of talent, which is propelling inflationary pressures on the market. The report calls on government to: Ramp up coordination of regional digital skills initiatives and better link local digital skills demand and supply; build digital understanding into all government retraining schemes – and include targeted support for software engineering and data analytics skills; and set an ambitious goal for 100% of the workforce to have basic digital skills by 2025.

Although each of these reports have a slightly different definition of the digital economy and economic activity, all recognise that the activity in the digital economy has been growing over the past decade. With it so too has the demand for individuals with digital skills. The sector has experienced indigenous growth and continues to show expansion through attracting FDI. The indigenous companies and those who have located here all recognise the need to quantify the number and understand better the types of future jobs that the sector can create. Several of the larger new investors have stated that they could attract more work from within their global business groups if there were the quantity and quality of staff available to them in Northern Ireland. In this document we illustrate the increasing demand for these skills and articulate the increasing skills gap in the Northern Irish economy.

The ICT Action Plan, produced by the Department for Employment and Learning (DEL), was written and a working group established to address the skills gaps in the Northern Irish economy. When DEL separated into the Department for the Economy (DfE) and the Department of Education (DE) the Action Plan was discontinued. Since

[2] Kieran, J. (2019), Skills Demanded by the Digital IT Sector, Department for the Economy
[3] Odell, S. (2019), Delivering Skills for the New Economy, CBI

then there has been little in the way of organising working groups to observe and analyse the economy for digital skills gaps.

The CBI Northern Ireland, informed by industry, has agreed to develop a ‘shared vision’ for the IT sector. The Department for the Economy will engage in this process, to ensure a closer relationship between, and understanding of, the skills demands of the sector and the skills provision available from the further education colleges and universities.

The Demand for Digital Skills

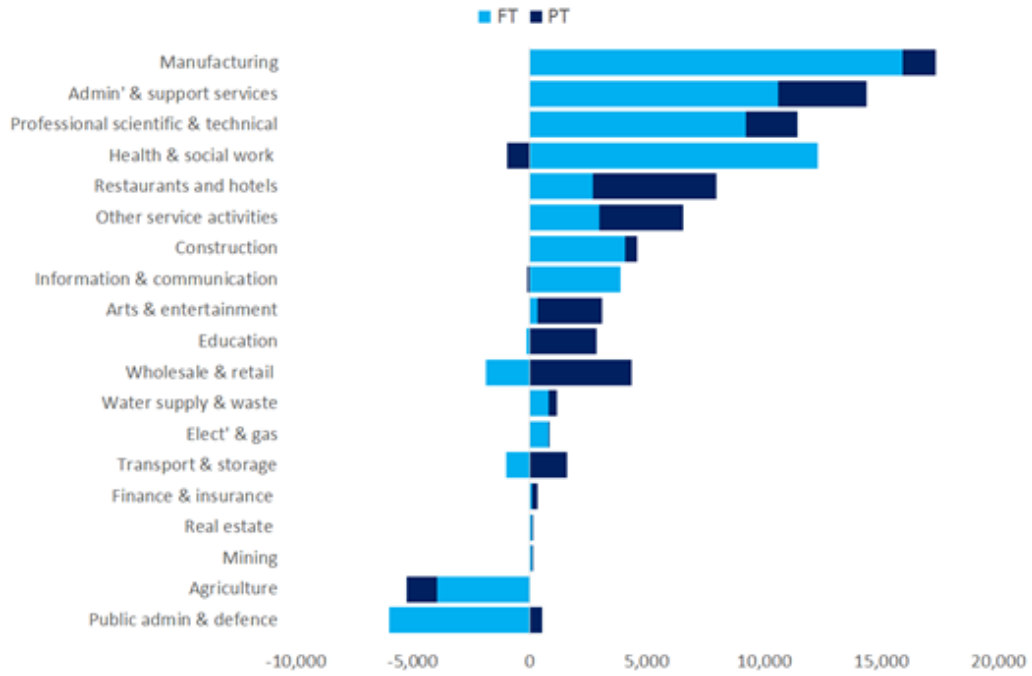
Understanding the demand for digital skills is vital if we are to ensure that there is a pipeline in place to deliver an adequate number of adequately skilled people to work in the industry. We complement publicly available datasets, scraped data from websites and survey data to provide an overview of the demand for individuals with digital skills in Northern Ireland. Initially taking a macro economy-wide perspective of employment, to an industry-wide view regarding the number of firms operating in the sector, then deeper into a micro skills and wages demands.

Economic Growth and Employment in Northern Ireland

The labour market in Northern Ireland has seen exceptional growth over the past decade, with unemployment at its lowest rate in 40 years and the employment level showing a strong upward trend since the nadir of the global financial crisis of 2008/2009. Specifically, from May 2019 to July 2019, Northern Ireland Statistics Research Agency (NISRA) reported that the unemployment rate in Northern Ireland was at 2.8% (28,000 people); far below the 3.8% unemployment rate for the UK as a whole, the 6.3% unemployment rate of the European Union and the 4.6% for the Republic of Ireland. During the same period, the employment rate was 72.0% (874,000 people).

The growth in employment has been widely felt by most industries across the economy. The largest growth has been felt by sectors increasingly reliant on digital skills such as manufacturing; professional, scientific & technical services; tourism; and information & communication. Overall employment change is shown in Figure 1. Importantly, when looking at the growth of the industries proportionally, i.e., you normalise with respect to the total number of individuals employed in the sector already, the growth in the information & communication sector is the largest with employment nearly doubling over the past 7 years.

Figure 1. Employment change in Northern Ireland by full time / part time split, 2012—2018



Source. NISRA

Changes in employment must consider two aspects: the net change in the stock of jobs – termed expansion demand – as well as the replacement demand in the economy. Table 1 shows the extent of the expansion and replacement demand for industries in Northern Ireland from 2013—2018.

Table 1. Expansion and replacement demand, 2013—2018

Gross demand	72,650
Expansion demand	6,880
Replacement demand	65,770
Filled from within the existing labour market	49,820
Net replacement demand	15,950

Source. Ulster University Economic Policy Centre

The distinction between expansion demand and replacement demand is important when considering industry growth and age. As industries mature and grow, increasing pressure is placed on the industry and the labour market to satisfy replacement and therefore more difficult to expand. The growth of the digital economy is relatively recent; however, it is notable that year-on-year there will be increasing pressure to simply employ to replace natural labour market churn.

The notable labour market statistic is chronically high economic inactivity rate, which sits at 25.5%, substantially higher than the 20.7% in the UK as a whole – a long-run feature of the Northern Irish economy.

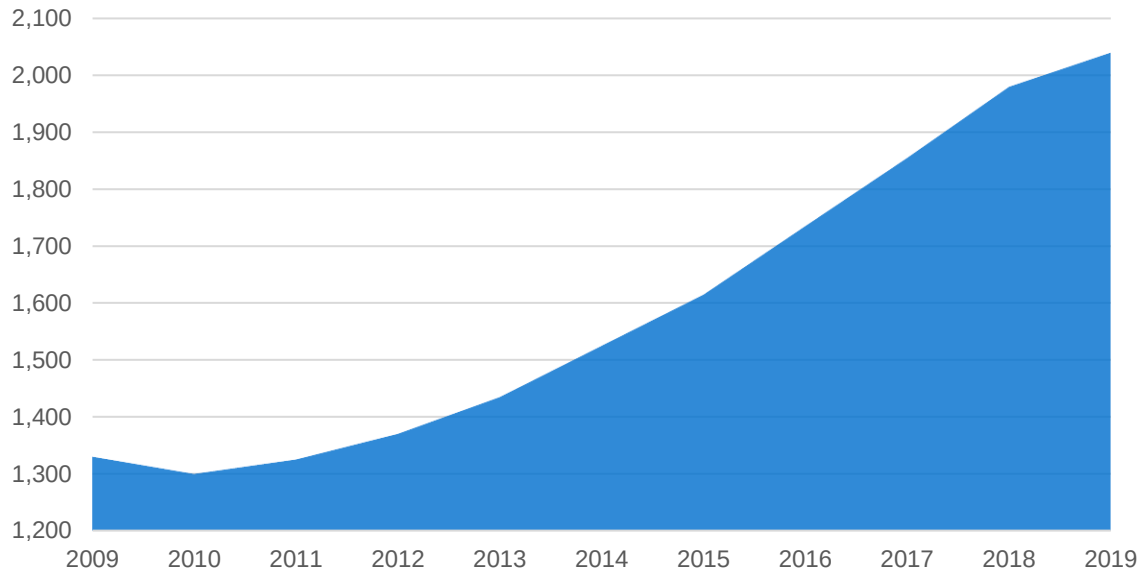
Industry-Wide Growth

Growth and geography of the information & communication sector

The number of information & communication firms registered in Northern Ireland has increased exponentially since the beginning of the millennium, with over 1,000 currently registered. This has been one of the most vibrant and dynamically growing industries over the past two decades and, in relative terms, has grown more than any other industry in Northern Ireland.

Typically, the growth of industries, sectors and cities follow a sigmoidal growth pattern, which can be seen in Figure 2. The sigmoidal growth pattern shown in the Figure suggests an initially slow, but exponentially increasing growth which has remained strong over the past 8 years.

Figure 2. Number of information & communication firms in Northern Ireland, 2009—2019

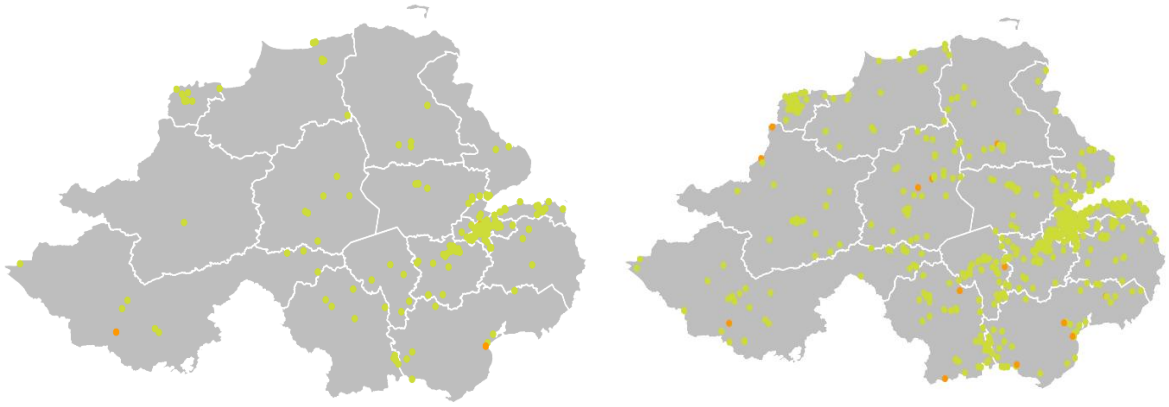


Source. IDBR, NISRA

Companies House provides a registrar of companies that are operating within the UK. Recently, they released an API which allows users to query their database of

registered companies[4]; this provides a wealth of information about each company, such as information on a company's directors, their registration history, their balance sheets, address, 5-digit SIC code, etc. We corelated the address where the company was registered with geocoordinates from Google Maps API to get an indication of the spatial growth of the industry over the last 20 years.

Figure 3. Geolocation of information and communication companies registered in Northern Ireland, 2013 – 2018



2013 **2018**

Source. Companies House & Google Maps

Figure 3 shows two maps of all information and communication companies registered in Northern Ireland on 2013 (left) and 2018 (right). There are several notable aspects; first, firms are disproportionately registered in Greater Belfast than any other area in the region. There are several reasons: there is a higher population density, there are more schools and University campuses are based in that area and there are increasing returns to agglomeration from knowledge spill-overs.

Second, the biggest relative areas of growth over the past 5 years have been in the North West of Northern Ireland, the Newry area and the business parks in the Lagan Valley area and Upper Bann. Again, agglomeration and knowledge spill-over effects are powerful attractors to start-ups and multinational firms establishing in Northern Ireland. Furthermore, basing a company near the border and transport links facilitates hiring frontier employees who are based in Ireland.

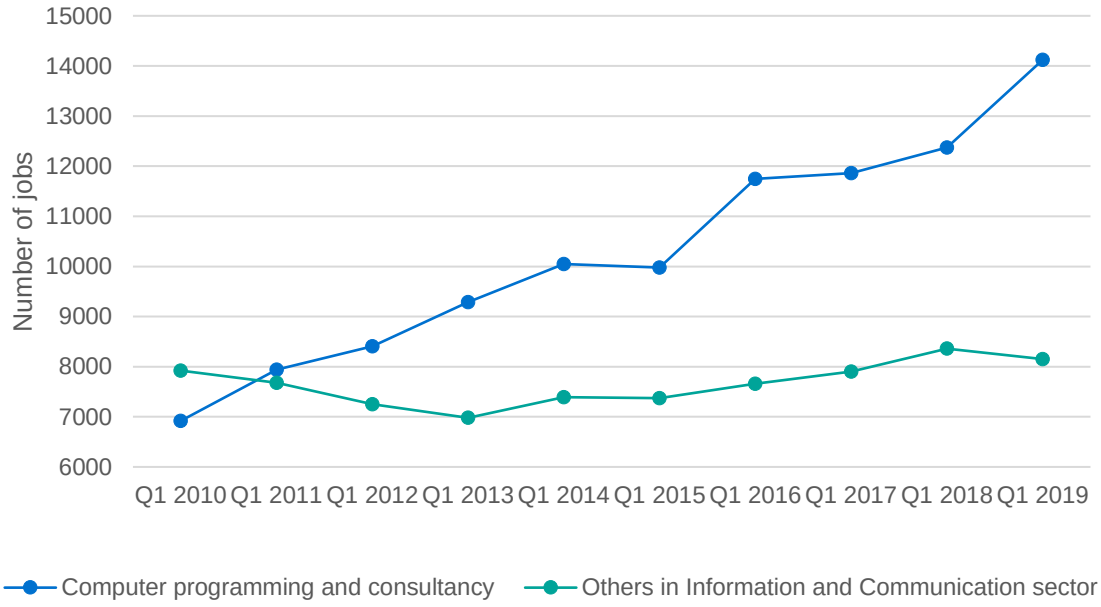
Sectoral and employment growth

Employment in the Information & Communication sector has grown by 7,430 (50%) since 2010. Most of this growth has come from Computer Programming, Consultancy

[4] Documentation on the Companies House API can be found here: https://developer.companieshouse.gov.uk/api/docs/ and a compressed spreadsheet containing basic company information for the whole of the UK can be downloaded here: http://download.companieshouse.gov.uk/en_output.html

and Related Activities, which has grown by 104%, from 6,920 employees in 2010 to 14,120 in 2019.

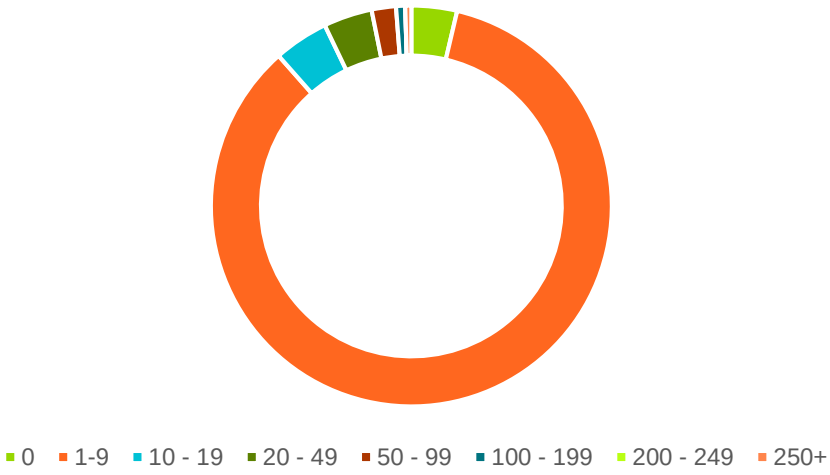
Figure 4. Employment in the information & communication sector in Northern Ireland, 2010—2019



Source. Quarterly Employment Survey, NISRA

Some of this growth has been spurred by FDI inflows. Overall, the number of foreign-owned Information and Communication companies has increased from 40 firms to 90 firms from 2009 to 2019. Currently, 4% of ICT businesses operating in Northern Ireland were foreign-owned, but these firms accounted for approximately 30% of ICT employment. Notably, the sector also enjoys higher birth rates than the NI average and the five-year survival rate in the sector is above the NI average. This suggests that at least some of the growth in the sector will be a result of indigenous growth.

Figure 5. Firm size distribution for the Information & Communication sector, 2019



Source. IDBR, NISRA

Annual and regularly updated studies are required to understand the current and projected demand for digital skills in Northern Ireland.

- The Department for the Economy and CBI to regularly use labour market information and the skills barometer to update forecasting reports to identify specific skills gaps faced by each sub-sector—cyber security, infrastructure management and applications management—and likely future skills gaps.
- The CBI will seek support from Invest NI to regularly gather information on the pipeline of the demand-side to better understand the range of future skills demands required in the sector.
- The CBI to provision a reoccurring regional survey to its members and related companies to understand their digital skills demands and gaps.

Invest Northern Ireland analysis

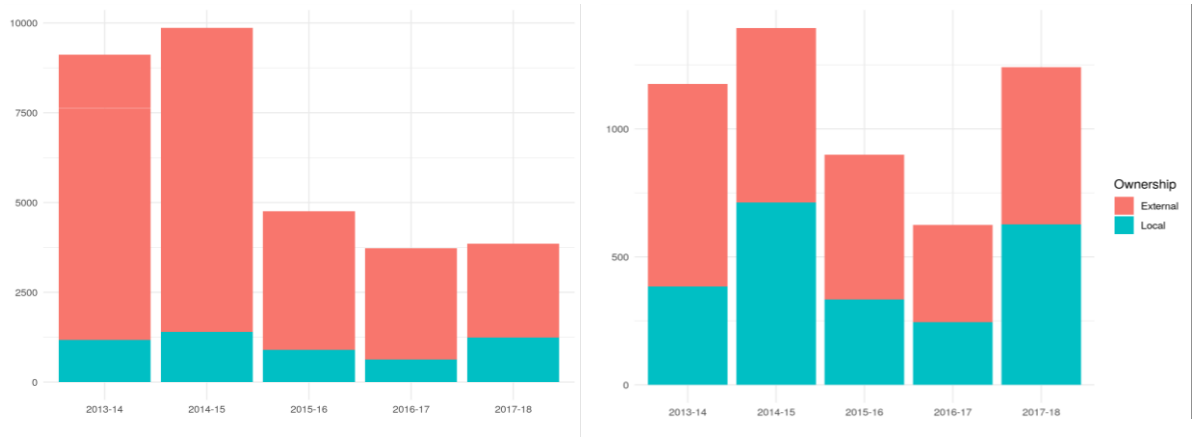
Invest Northern Ireland released five years' worth of investment and employment data on Open Data NI website[5]. The data provides details of the companies funded, total investments, Invest NI's financial assistance, the number of jobs assisted, where the firm is foreign or local and what constituency the investment will take place.

From 2013 to 2018, Invest NI provided financial assistance to 11,265 projects, supporting the creation of 31,317 new jobs, spending a total of £522,329,158 (on average,

[5] Invest NI data can be found here: https://www.opendatani.gov.uk/dataset/open-data-up-to-17-18-csv-file-uploaded-csv-13-to-2016-17

£16,678.77 per job created). In terms of the information and communication sector, 5,335 new jobs have been supported by Invest NI across 1,562 projects.

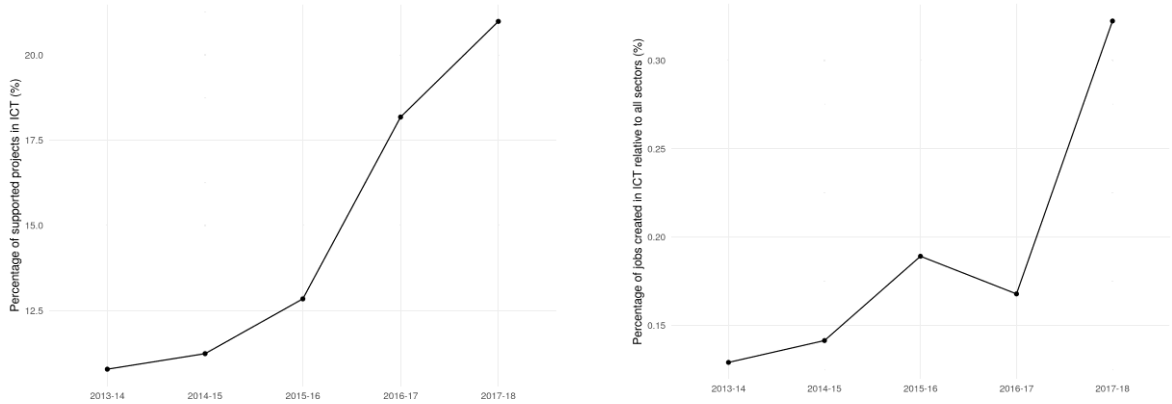
Figure 6. Number of jobs assisted across all industries (left) and just the Information & Communication sector, 2013—2018



Source. Invest Northern Ireland

Figure 6 shows the total number of jobs assisted by Invest NI across all sectors (left) and just within the Information and Communication sector (right). From 2014-15 to 2015-16 state-aid changes led to a significant decline in the amount of funding given to Invest NI. This was reflected in the number of Information and Communication projects supported over 2015-16 and 2016-17; but has gained a lot of momentum since 2017 despite a low amount of total investment by Invest NI. Indeed, there has been a significant focus on the Information and Communication sector over the last two years, which adds stress on the supply of labour.

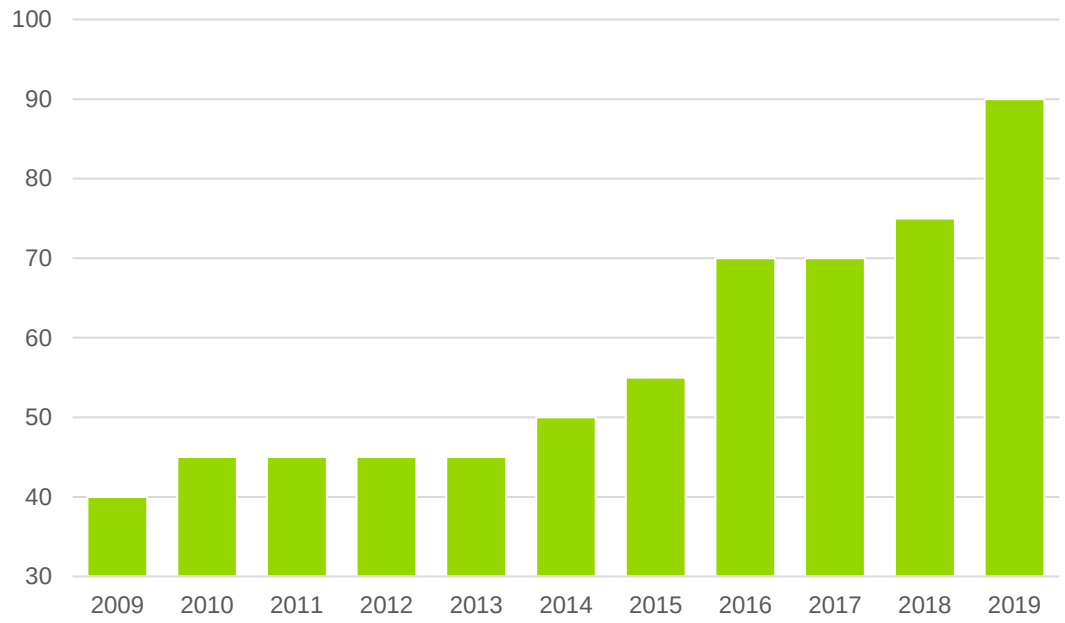
Figure 7. Proportion of projects invested in Information and Communication (left) and proportion of jobs created in Information and Communication (right), 2013—2018



Source. Invest Northern Ireland

Figure 7 shows the extent of this increased focus on the Information and Communication sector. Since the financial year 2013/2014 the proportion of projects supported in the Information and Communication sector has increased from just over 10% to almost 22% in the financial year 2017/2018. Likewise, the proportion of jobs supported over the same time period increased from 13% within the sector to over 30%.

Figure 8. Number of foreign-owned information and communication firms, 2009—2019



Source. IDBR, NISRA

Skills and Wages Demanded

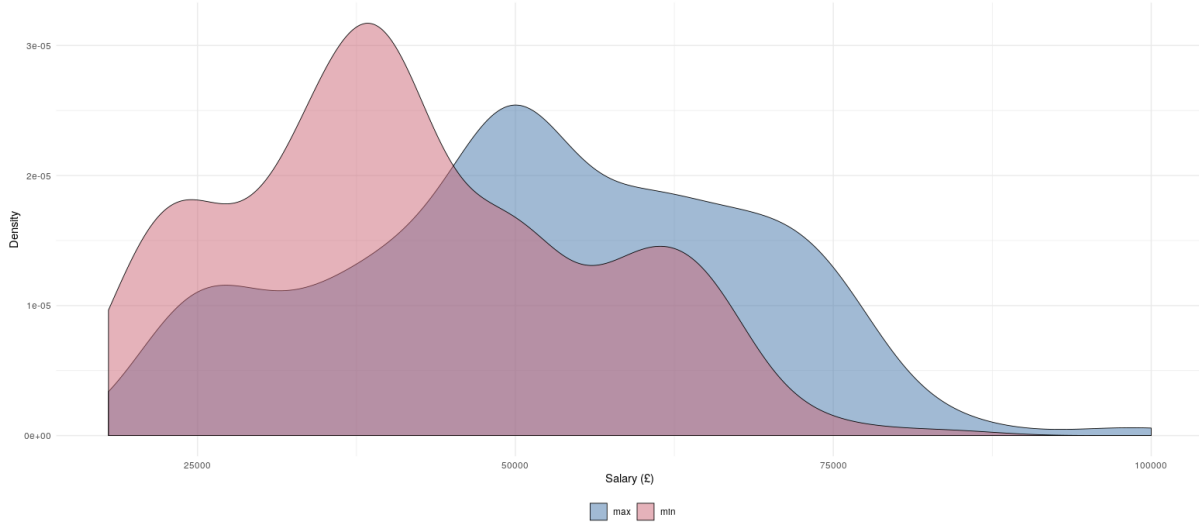
The CBI developed a programme that scrapes vacancy data for IT professionals in Northern Ireland[6]; this includes information in salary ranges, programming languages and technologies desired, and level of employee required. The tool was run across several Northern Irish recruiters and job portals during the month of April 2019. Note that during the analysis, if a salary range is given in the job advert—which occurs most of the time—we take the highest figure within the range.

We collected 805 permanent IT vacancies were collected from January 2019 to April 2019 all at different levels of seniority. At most, job vacancies were advertised for around 6 months before being filled; on average, the vacancies were being filled in 2 months.

[6] You can find more information on the programme to scrape Northern Ireland IT vacancies here: https://github.com/cbi-ni/it-vacancy-scraper

The current wage distribution for all IT vacancies can be seen in Figure 9. As expected, wages scale with responsibility and seniority of the role. Although wages also scale with respect to the number of years of experience this relationship deteriorates above 5 years. Beyond 5 years of experience the wage distribution widens from approximately £55,000 to £120,000.

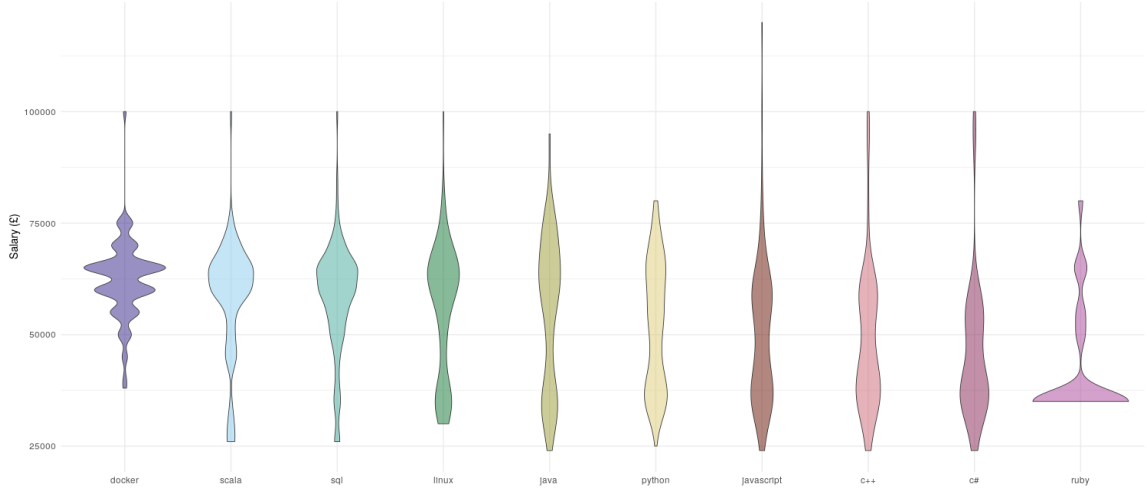
Figure 9. Northern Ireland salary distribution for permanent IT professionals, August 2019



Source. CBI scraping tool

Given the typical salary ranges posted in job adverts, we calculate that the average wage across all collected professional IT vacancies in Northern Ireland was between £40,000 and £50,000. Note that this is indeed the wage distribution for the roles that are in demand, and not necessarily for the market as a whole. Therefore, it could be accurately assumed that the average wage range scraped from job advertisements are higher than the industry average. Unsurprisingly, however, wages offered by FDI companies are typically at an 18% to 20% premium relative to relatable roles in local firms.

Figure 10. Northern Ireland salary distribution for popular programming languages & technologies.



Source. CBI scraping tool

Figure 10 shows that wages across all popular languages and technologies were largely aligned. Scala had both gained in popularity and salary premium, offering the highest average wage. So too had experience using containerisation technologies such as Docker and Kubernetes. Older and more low-level languages, such as C and FORTRAN, were relatively less in demand and given a lower wage premium. This may be due to the fact that more greenfield, and less legacy, software development was being conducted in Northern Ireland, therefore did not require as much legacy code to be maintained and updated.

Importantly, the technologies used between large, small and entrepreneurial firms in Northern Ireland were highly alike. Out of the companies surveyed it was found that 87% of firms used Java, 72% used SQL or a SQL database, 54% used Python within their technology stack, and 82% used Javascript. More than 60% of companies were either using, or had an eminent interest in using, machine learning or artificial intelligence technologies.

When investigating the challenges and opportunities for employers and employees in an economy with AI, the Department for the Economy's Research Bulletin[7] analysed the future need of STEM skills and subjects in the future. It sought to understand the potential job opportunities that AI can create and the skills that people need to take advantage of these jobs. The analysis uses Burning Glass Technologies[8] to understand the demands of business for certain occupations. They find that over the period January 2017 to June 2018, there were a total of 17,071 active AI job postings across

[7] Clarke, A. and Byrne, T., Understanding Artificial Intelligence Jobs and Skills Needs, Department for the Economy, Analytical Services

[8] For more information on Burning Glass Technologies solution see: https://www.burning-glass.com/products/labor-insight/

the UK with just 211 (or 1.2%) of these in NI. Across the UK, three occupations account for over half of AI jobs posted:

- Programmers and software development professionals;
- IT and telecommunications professionals; and
- IT business analysts, architects and systems designers.

As expected, the largest demand is for IT and software jobs. However, there are other occupations where AI is creating jobs in Northern Ireland, such as management consultants and business analysts, marketing and sales directors, biologicals scientists and chemists and Higher Education teaching professions. This ripple effect is being felt throughout the economy.

Table 2. Top 10 subjects sought by technology employers, January 2017 – June 2018

Rank	Subject area	UK vacancies	Skills barometer
1	Computer science	2895	Under-supplied
2	Engineering	1589	Under-supplied
3	Mathematics	1301	Under-supplied
4	Computer software engineering	640	Under-supplied
5	Business administration	545	Over-supplied
6	Electrical engineering	504	Under-supplied
7	Statistics	484	Broadly in balance
8	Physics	430	Under-supplied
9	Computer engineering	234	Under-supplied
10	Economics	154	Over-supplied

Source. Department for the Economy

According to the Department for the Economy report, the most desired subject in both and the UK over the next decade is in computer science. This is largely informed by the Skills Barometer, which suggests that there will significant demand for STEM subjects in NI subsequently leading to a significant undersupply of people with STEM qualifications. Indeed, computer science is forecast to have the greatest gap between supply and demand, and the competition for suitably qualified graduates could therefore be a key constraint in supporting the growth of the AI sector within NI. There may, however, be opportunities for employers to recruit from skilled graduates with subjects such as economics, business studies and statistics where there is not expected to be

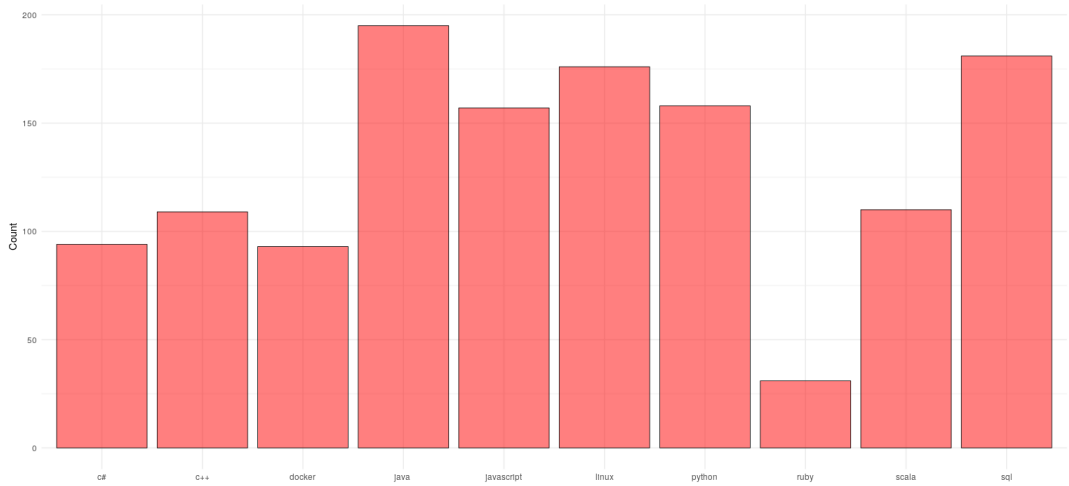
an under-supply; initiatives such as Assured Skills Academies could helpfully play in a role in retraining graduates with the skills needed for jobs in the technology sector.

Using a similar technique as Burning Glass Technologies, the CBI developed a programme that scrapes vacancy data for IT professionals in Northern Ireland; this includes information in salary ranges, programming languages and technologies required, and level of employee required. The tool was run across several Northern Irish recruiters and job portals during the month of April 2019.

Specific skills that employers are looking for include general software engineers, data scientists, full-stack developers and cyber and IT security specialists. The most common level of interest is in experienced hires (senior development roles) with 3 to 5 years of working experience.

Figure 11 shows the number of IT vacancies by programming language and technology. The most wanted programming language that employers looked for in Northern Ireland was Java, followed by SQL, Javascript and Python. Mobile application development was relatively low, with only a handful of employers currently looking for employees with knowledge in Kotlin, Objective C and Swift.

Figure 11. Number of IT vacancies by programming language and technology, August 2019



Source. CBI tool to scrape job adverts

Containerisation technologies, such as Docker and Kubernetes, have increased in popularity over the past few years, reducing the importance of VMWare and other VM software. Web frameworks, such as Spring and Django, as well as continuous integration suits, such as Jenkins and Travis, continue to remain important.

The evidence on the demand for digital skills is clear. Over the past decade there has been a significant surge in the overall demand for labour in the economy, leading to reduced unemployment and economically inactive rates. A significant proportion of this demand is in digital skills – either with respect to digitisation and automation of traditional industry, or the substantial growth of the information & communication sector. Although there has been an increased interest in FDI that demand high levels of digital skills, much of the growth is by local firms. This increased demand for digital skills throughout the economy has been reflected in inflationary wage levels – particularly for Javascript, SQL, and Scala.

The Supply of Digital Skills

Inflationary pressure on wage levels for individuals with digital skills may not signify an increase in demand alone; but can also signal a lack or lag in the supply of appropriately trained labour. A signal of an over-heated market. This Section analyses the supply chain of people and digital skills to the market, starting from the supply of skills at Higher Education and Further Education, before looking at the performance of the Assured Skills Programmes and the longer-term post-primary supply chain.

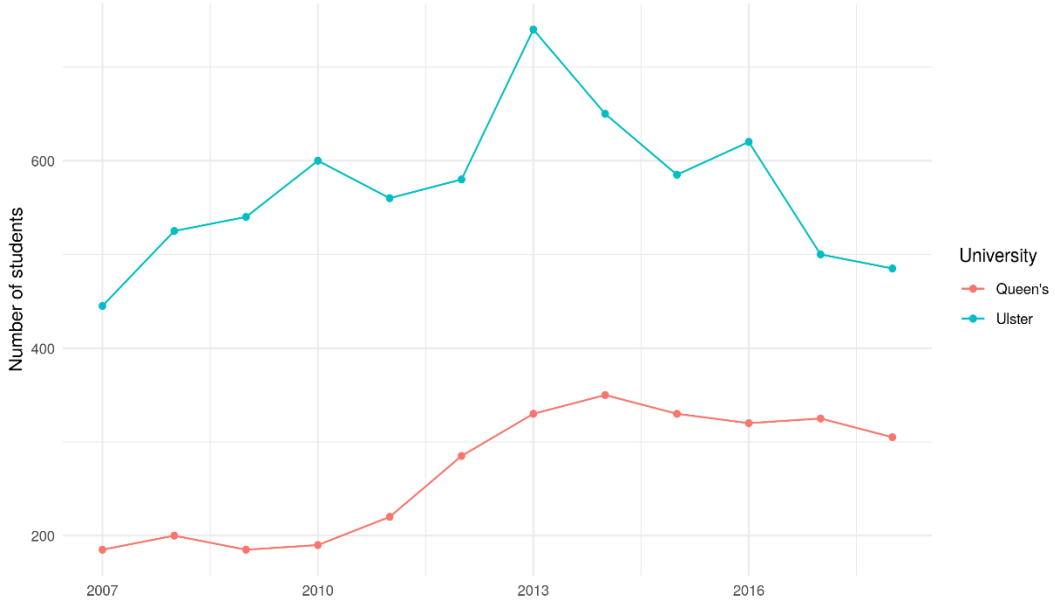
Supply of digital skills at Higher Education

For clarity, higher education refers to tertiary education leading to an award of an academic degree; encapsulating RFQ levels 6, 7, and 8. We therefore consider undergraduate and postgraduate university education. Two main data sources are published regarding the uptake of courses that add to the pool of appropriately skilled labour – the Universities and Colleges Admissions Service (UCAS) and the Higher Education Statistics Agency (HESA). For completeness we consider enrolment and applications from both data sources for NI institutions.

UCAS applications and acceptances

UCAS provides granular data regarding the number of applications and acceptances for each UK university, the domicile of the applicant, the specific course title and code, and the applicants' preference of university and course, i.e., first preference and insurance choices. Although UCAS data shows the number of acceptances, it does not provide a finalised figure of how many students sit in the course. Moreover, the figures below do not consider students that have taken a major-minor combination with, for example, computer science.

Figure 12. Total number of UCAS acceptances for 'Computer Sciences' for NI universities, 2007—2018



Source. UCAS

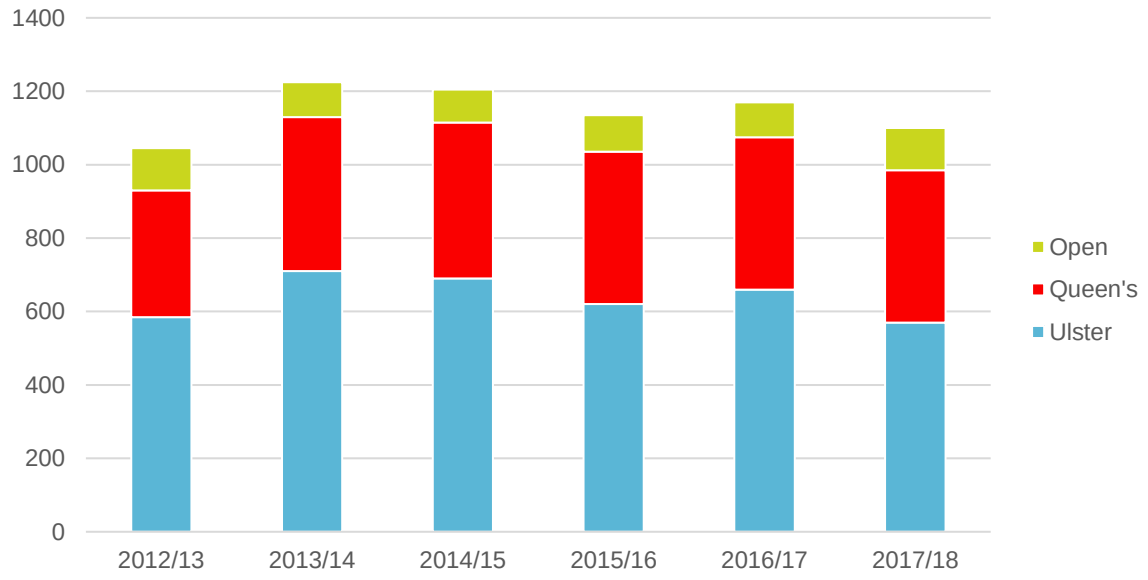
According to UCAS, the total annual number of applications accepted in Computer Sciences[9] in both Ulster University and Queen's University Belfast has fallen since the overall peak at 2013. The sentiment of this downward trend since 2013 matches what is being felt by businesses.

HESA data overview

HESA data considers the full in-take of students into specific courses, major-minor intakes, and the in-flow of students from alternative pathways. Although higher than UCAS data, the overall trend largely matches that of the UCAS data. Open University data is also considered here.

[9] This is defined in terms of the JACS subject code, which includes subject areas such as: Computer science; Information systems; Software engineering; Artificial intelligence; Health informatics; Games; Computer generated visual & audio effects; and Others in Computer sciences.

Figure 13. The number of full and part-time first year Computer Science students, 2013—2018



Source. HESA

Both data sources show that the uptake of technical studies that deliver digital skills to the market in NI is diminishing at the undergraduate level. The Skills Barometer highlights that the main supply to the digital economy is at NQF Level 6 – bachelor's degree or equivalent – which is also the level primarily demanded by companies.

The imbalance of student demand and provision

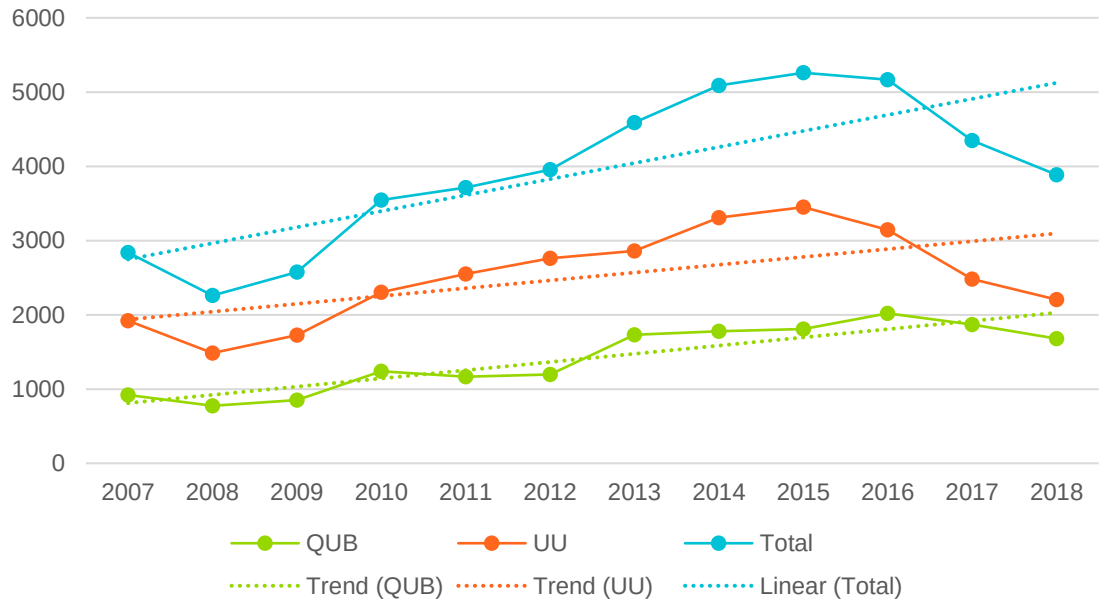
It is important to disentangle whether there exists a lack in demand for students to undertake a degree in computer science or related subject, or whether the restriction is on the supply-side, i.e., whether there is a restriction in the number of seats available at University-level.

We find that, from 2007—2017, increasingly the supply of places at higher education is not supporting the overall demand from prospective students. Indeed, we are seeing that although the demand for the places remains high—indicated by the number of applications to Northern Irish universities—there is an increasing divergence between the number of applications to computer science and related courses, and the number of acceptances in these fields.

Figure 14 shows how stark the difference between the demand and supply for computer sciences in particular since its nadir of 2260 in 2008 and its overall peak of 5260 in 2015. However, since 2016 the attractiveness of these technical courses has diminished for NI institutions. The trend has continued for the academic year 2019 / 2020. This is reflective of a number of issues:

a. A declining population of 16-18-year-olds;
b. A reported national decline in the number of teenagers interested in studying sciences and technical subjects; and
c. Political instability both nationally and regionally with Brexit and a lack of local government which makes studying abroad more appealing.

Figure 14. Difference between the number of applications and number of acceptances for Computer Science, 2007—2018



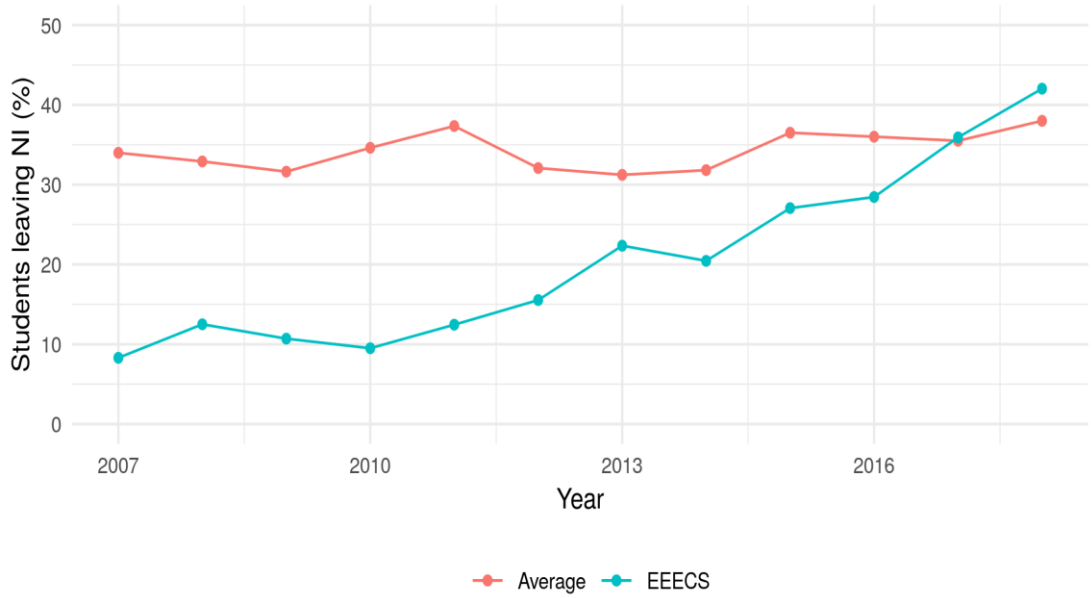
Source. UCAS

Although enlightening, the data does not show two important aspects: (1) The quality of the candidates' application. Indeed, although still over-subscribed, the data does not consider the internal readjustments to entry requirements required to be enforced by the Universities to adequately fill places. This has become a pressure recently as applications have declined. (2) Whether a candidate has put multiple applications in for the same course. However, on this point, the ability for a student to place multiple applications to a single university has not changed since 2007, so is a relatively moot point.

University student migration from Northern Ireland

The natural response to a decline in the number University spaces available during a time where the number of applications is relatively healthy from prospective students is that students seek places elsewhere in the UK and Ireland. Consequently, the proportion of students leaving Northern Ireland to study electrical engineering, software development and computer science has increased over the last decade.

Figure 15. Percentage of students leaving Northern Ireland to study elsewhere in the UK, 2007—2018



Source. FactCheck NI & UCAS

There are many options open to prospective students who are considering to study computer science in the across the UK. Indeed, the university and college course comparison website, UniStats, shows that there are 995 first degree (e.g., BA, BSc) courses in Computer Science across 124 universities in the UK. We consider the closest substitutes to both Queen's University Belfast and the University of Ulster both in terms of quality of the education and the entry requirements for students.

Table 3. List of alternative Russell Group universities

University	A-Levels required	Fees (£)
University of Liverpool	ABB	9,250
University of Edinburgh	AAA - ABB	9,250
Cardiff University	ABB-BBB	9,000
University of Glasgow	AAB-BBB	9,250
Queen Mary University of London	ABB	9,250
Queen's University Belfast	ABB-BBB	4,275
Ulster University	ABB	4,275
University of York	AAB - ABB	9,250

Other pathways at Higher Education

To this point we have only discussed the supply of undergraduate students to the market. Higher education provides other pathways, including:

- Postgraduate courses in specialist roles and conversion
- Distance-based learning
- Upskilling courses.

The provision of postgraduate conversion courses provides a mechanism to immediately respond to high-level digital skills needs in the economy. Over the past decade, NI universities have seen a significant interest in computer science conversion courses, which signals the opportunities available in the digital economy and the potential that careers advice may not be enough if people are retraining.

Distance-based learning provides another mechanism to supply digital skills to the market in the near-term. These courses are typically targeted to those already in employment and want to transition into the digital economy. They also provide a flexible pathway for the economically inactive to transition to employment. This form of learning provides one of the most promising opportunities for broadening the pipe for management-level hires in the digital economy.

Upskilling courses provides life-long learning opportunities for those employed in the digital economy or those that support the digital economy, for example, teachers. To remain competitive in the global marketplace, continual professional development through upskilling is essential.

Supply of Digital Skills at Further Education

Over the past five years, Further Education colleges have increased their offerings as well as their intake in students learning digital skills. In terms of overall supply, this partially compensates for some of the decline seen at Higher Education level. The flow of students through Further Education can ultimately lead to a boost in the number of NQF Level 6+ qualifications. For example, students can complete foundation courses in Belfast Met before continuing their studies at Ulster University to complete an undergraduate degree. This route requires students to complete a two-year course at Further Education before undergoing a three-year top-up course (including a placement year) at a Higher Education institution.

Although an attractive proposition for many, students increasingly leave Northern Ireland to continue their studies at Higher Education institutions in England. Typically, most of these students will not return to Northern Ireland to work. The reason for the outflow is because they can attain a Level 6 qualification one year faster in other Universities. This is something that is in desperate need for reform.

An alternative pathway for Further Education students can take is to attain a Level 5 qualification such as a foundation degree or an HND. Although valuable to the digital

economy, greater effort needs to be made between industry and FE educational institutions to understand whether the needs of industry can truly be met by a Level 5 qualification. We found that, at a minimum, the vast majority of firms filtered applications on the basis of a 2:1 undergraduate degree or above in computer science or another relevant field. Notably though, smaller firms would be more prone to investigate an applicant's portfolio and broader abilities when screening, but less so in larger firms due to obvious resourcing issues.

Further education plays a critical role in filling gaps in the supply of people and skills. They need to be facilitated by more flexible and competitive entry and exit points between FE and HE and a better understanding of the skills taught at Level 5 and what is required by industry.

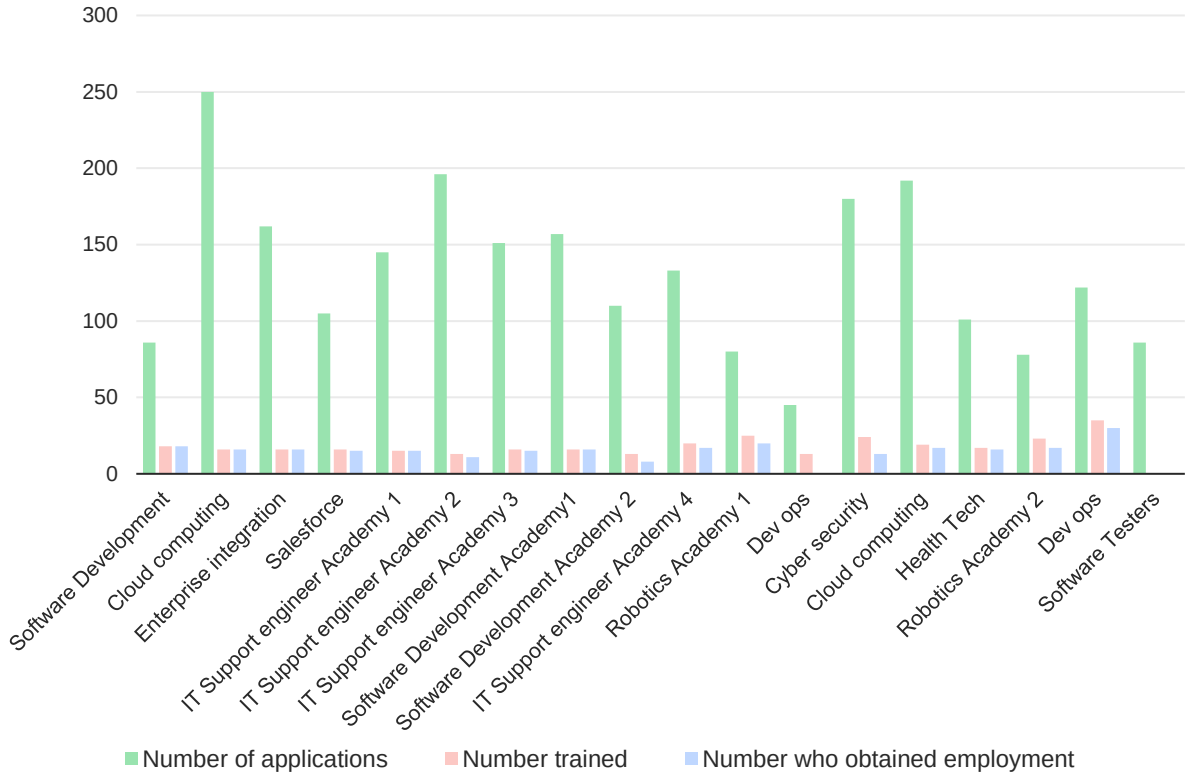
Assured Skills Programme

For background, when a company is interested in creating jobs in Northern Ireland, Assured Skills provides the necessary support to deliver a skilled workforce through the delivery of pre-employment training programmes. The Assured Skills programme, which is funded by the DfE, seeks to assure potential investors and existing employers considering expansion, that the skills they need to support a growing business can be found in Northern Ireland. It does this by employing all of the DfE's responsibilities for the higher and further education sectors and the Department's skills and training programmes.

Under the Assured Skills 'Academy Model', where an individual company or consortium of companies have an identified skill needs, DfE will consider developing a short-term pre-employment training intervention to meet that need. This typically involves a six to eight-week pre-employment training programme delivered by a local college or university and, where applicable, this may be followed by a four to six-week placement with a participating company. The intervention is designed to lower the recruitment risk for companies by providing candidates trained with the initial skills for the opportunities that are available.

Several Assured Skills Programmes have been hosted to specifically supply digital skills to the market. These have been in the areas of data analytics, software development, software testing, cyber security and DevOps.

Figure 16. Number of applications, trained individuals and those who have obtained employment from Assured Skills Academies



Source. Department for the Economy

Figure 16 shows the number of applications, trained individuals and individuals that found employment from the digital skills academies As of June 2019, Assured Skills Academies focussed on digital skills have trained 315 individuals and 260 of which have found employment. Note that the demand for these skills academies have been significant; overall 2,379 people have applied to the Skills Academies. Overall, therefore, the skills academies serve 13.2% of people that are interested in developing specific skills. Note, however, that the total number of applications does not take into consideration duplicated or unqualified applicants.

The Assured Skills Programmes provide a pro-active response to short-term skills shortages. They allow industry to directly tailor the content of the courses and are extremely welcomed.

The existence and popularity of Assured Skills Programmes highlights their practicality, but also highlights market failure that the number of skills is not being supplied to the workforce through traditional means. Whether or not the persistence of the Assured Skills Programme is a long-term solution or not is debatable, but the frequency of their use emphasises the need to boost the supply of relevant skills and the alignment of FDI projects better to the people and skills in the market.

Higher-Level Apprentices

Higher-level apprenticeships (HLAs) provide a relatively under-utilised pathway for post-school students to follow a career in the digital economy. The pathway provides a funded and paid way for students who learn whilst being in employment. A relatively new potential path for students, it has a small but sustained supply of around 40-per-year in programmes supported by companies such as Deloitte, PwC, and Kainos.

This scheme is under-utilised in the sense that it is largely subsidised by government, but uptake is relatively low and only used by already significant employers. In our survey of software-orientated companies (Section 5), we found that there were several reasons why HLAs were not used more. These included:

- Issues with timings. Firms required more flexibility regarding the timings that students were free to work and study.
- Billable hours. Although being paid a wage by the company, HLAs were not billable for at least the first year of employment.
- Early-stage HLAs require significant support which detracts from more experienced, valuable staff.
- Security requirements for employees to work on projects that may not be available to non-full-time staff, such as apprenticeships.
- Some firms felt that the content of the courses was not relevant or could be taught in a much shorter time-scale.
- Smaller firms – which is most of the industry – simply do not have the capacity to investigate HLAs.
- Incentive problems. There are fundamental perverse incentive issues that:
    - Promotes poaching from larger firms that who are able to absorb the investment into the students; and
    - Do not actually increase the pool of labour – simply provides an alternative route for students that would have already entered the labour force. In the long-run companies may be better just to wait for students to graduate from tertiary education.

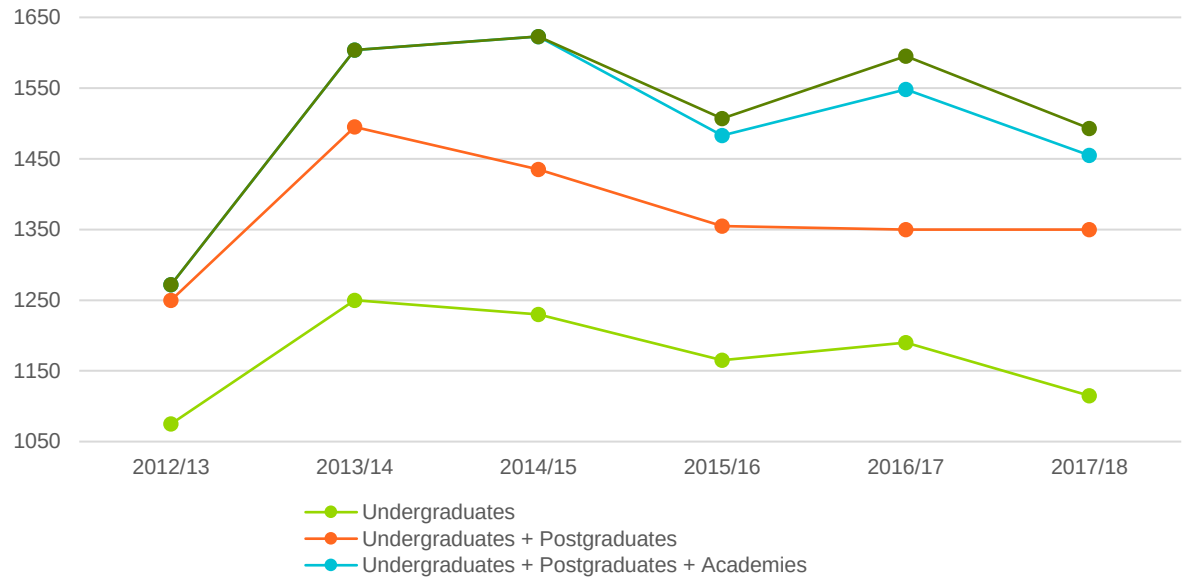
Where available, these issues need to be addressed before we see any significant interest from employers and uptake of HLAs. The intricacies of the digital economy need to be considered and the model adjusted accordingly.

Better communication must be made to smaller firms and reduce the burden of taking on HLAs, educational institutions need to work with industry to add more flexibility to course content and class times, and government to recycle the Apprenticeship Levy from the block grant and partially fund HLAs salaries for the first year until they are at an appropriate level and are billable by industry. HLAs provide a positive pathway, but require more discussion and development before they are attractive to the digital economy.

Overall entry-level supply

Figure 17 shows the total entry-level supply of digital skills to the digital economy of Northern Ireland. This supply takes into consideration undergraduates and postgraduates from NI universities[10], individuals that have completed assured skills academies, and HLAs.

Figure 17. Total entry-level supply of the IT sector



Source. Department for the Economy & Invest NI

As previously noted, the entry-level supply of undergraduates increased from 2012 to 2013, in accordance with the 2012 ICT Action Plan. However, the supply has retrenched significantly over the past 5 years. The number of HLAs and individuals from skills academies act as a top-up, but not to the same level as the 2013—2015 supply or what is increasingly required by the Northern Irish economy.

HLAs provide an alternative route for students to attain the skills and enter the sector. It is an attractive pathway for students as they get paid for going through the process and do not accumulate student debt. However, few companies engage with the programme relative to the size of the industry. Northern Irish firms have cited several reasons why engagement is low. These reasons include issues with timings; students are inexperienced and therefore not billable for a period; firms are too busy and a short of resource already; significant resource is required to support apprentices, which distracts experienced staff; security requirements can be required for employees. Many

[10] HESA data is used to estimate the number of undergraduates and postgraduates in the entry-level supply.

smaller firms also do not know how to engage with the HLA process and often do not have the capacity to explore the opportunities further.

Digital skills at post-primary education

We proxy the long-run supply of digital skills to the Northern Irish labour market by reviewing the number of students enrolled in ICT-related subjects accredited by the Council for the Curriculum, Examinations and Assessment (CCEA). We collect data for GCSE-level, AS-level and A-level from the school year 2011/2012 to 2018/2019, the data can be obtained from the CCEA website[11].

The courses available at all levels have changed substantially over the time period. At GCSE-level, the ICT course has changed during the year 2018/2019 to the formation of two distinct courses; *Digital Technology (Programming)* and *Digital Technology (Multimedia)*. The introduction of the digital technology courses was taken to make the education and digital skills offering more thorough. The result has seen a significant initial drop-off of pupils taking the course. It will be important to see whether we will see a longer-term uptake of the courses or if the number of students taking it will be diminished relative to the numbers that previously took ICT.

AS-level and A-level have seen the introduction of *Software Systems Development*, a more technical course geared towards programming and application development. CCEA have recoded that students who take this course at A-level find it easier to adapt to the workload and syllabus at University and subsequently have a significantly lower propensity of dropping out at higher education. The Software Systems Development module as been created by CCEA; but has only been adopted by approximately 20% of schools in the region. AS-level and A-level have also seen the introduction of the *Digital Technology* module which has replaced the ICT course.

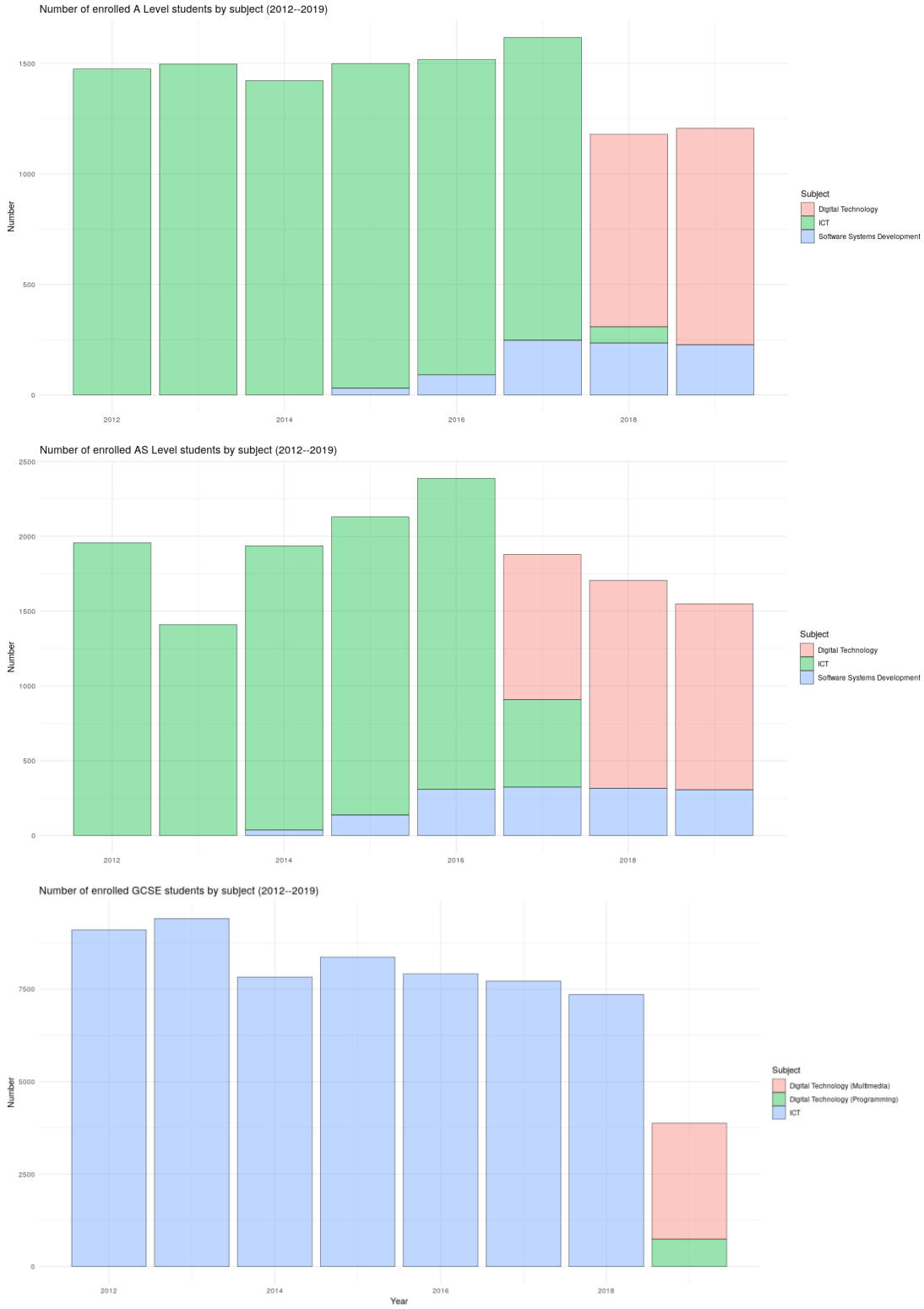
The enrolment data shows that over the past few years, the number of students taking ICT and related courses has fallen, particularly since the introduction of the *Digital Technology* and *Software Systems Development*. Indeed, the diminished number of students enrolled in these subjects has persisted since their introduction. This has had an impact on the number of applications for Computer Science related subjects over the past two years. Note that this fall in the number of students enrolled in ICT-related courses also coincides with an overall decline in the population aged between 15 – 20 years old.

Concern rests in three areas regarding post-primary education. First, there is concern that the initial reduction in the uptake of Digital Technology (Programming) and Digital Technology (Multimedia) at GCSE-level persists over a substantial period and if this reduction has a knock-on effect to the level and quality of digital skills in the labour market. Second, there currently exists a lack of statutory curriculum at Key Stage 3,

[11] All GCSE and GCE results are available from CCEA at: http://ccea.org.uk/more/research_statistics/qualifications/results

which is detrimental to students and teachers. Third, the development of the new courses has not been complimented with Continual Professional Development (CPD) for teachers to facilitate teaching new concepts and advanced notions. Not addressing these three main issues will exacerbate issues regarding digital skills.

Figure 18. Estimated number of post-primary students enrolled at A, AS and GCSE level, 2012—2019



Source. CCEA

Recording the Digital Skills Gap

The CBI Northern Ireland conducted a survey from March to April 2019 that sought to understand the demand for specific digital skills in Northern Ireland. Forty-three (43) software-oriented firms responded to the extensive survey on their digital skills needs. The purpose of the survey was to understand the number of people and the general skills that are required by firms operating in the region. The respondents ranged from start-ups to corporations and from locally established firms to multi-national foreign direct investment projects.

At a high level, the survey confirmed the suspicions evident from demand and supply data: highlighting that many firms operating in Northern Ireland are experiencing digital skills shortages. Although firms throughout the region are experiencing difficulties hiring people with the correct skills, many are attempting to organise internal short courses and meet-ups, up-skill or retrain staff and expand operations elsewhere. Overall, there is a general concern that the provision of digital skills is currently unstable and will continue to be so unless there is strong non-overlapping collaboration between industry, government and educational providers.

Areas of digital skills gap

At a more granular level, eighty-six percent (86%) of respondents suggested that they were currently experiencing digital skills shortages. Skills shortages were skewed more towards larger firms, however smaller start-ups still expressed an issue with a lack of appropriately qualified candidates. The biggest reported specialist skills gaps were in software engineering and development (88%), artificial intelligence specialists and data scientists (69%), cyber and IT security (65%) and full-stack developers (51%).

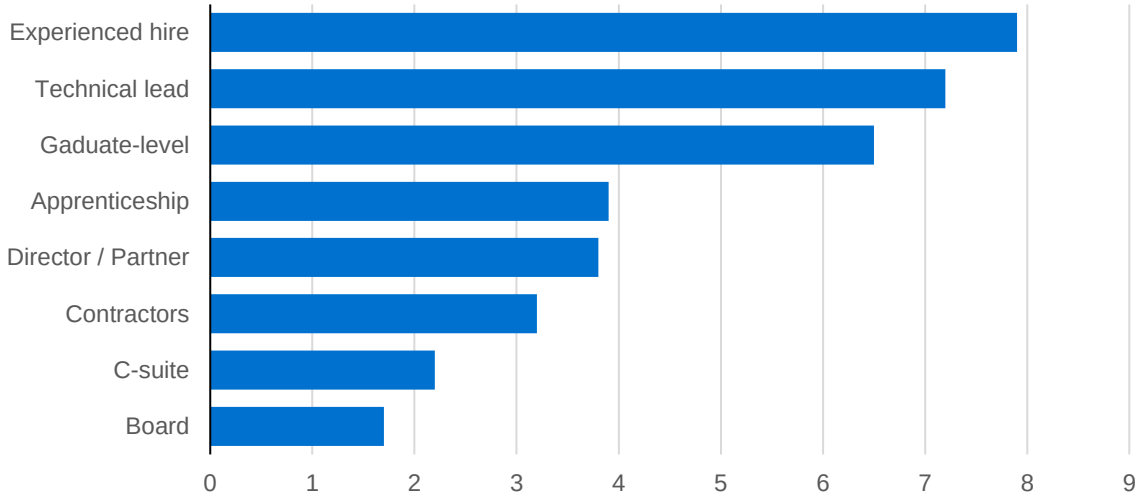
Notably, one of the most demanded skills required by businesses were soft skills (71%); such as presenting, problem-solving and team working. Notably, UX specialist / UI development was relatively low in terms of the skills gaps and was also an aspect that, in relative terms, firms wouldn’t foresee themselves investing as much in UX and UI development in the future.

Table 4. Top ranked digital skills that businesses are struggling to hire

Skill	% of businesses struggling to hire this skill
Software engineer / developer	88%
Artificial intelligence specialist	69%
Data scientist / data analyst	67%
Cyber and IT security specialist	65%
Full-stack developer	51%
DevOps engineer	44%
UX specialist / UI developer	42%
Product owner & solutions architects	40%

Firms were asked to rank at what level they experienced the greatest skills gap. They tended to have the greatest skills gaps in more experienced roles. In order of shortage, firms suggested gaps in experienced hires (employees with 3—5 years' work experience) and technical leads (at least 5+ years' work experience). Note that there exists a significant gap between the desirability of graduate-level and apprenticeships. Indeed, although larger firms have the capacity to take on apprenticeships, smaller firms do not but may have a need for them.

Figure 19. Ranking of the extent of the skills gaps that exist within Northern Irish organisations



Ninety-five percent (95%) of businesses expected their need for digital skills to grow over the foreseeable future. Businesses expected to feel their most acute digital skills needs over the next 3-5 years (82%), however their short-term digital skills needs were not trivial; with 61% of businesses expecting to feel digital skills needs over the next 1-2 years.

Just over half of the respondents said they were confident that they would be able to hire people with the digital skills for their business today. This sense of confidence diminishes as the time horizon extends to the future; for example, 80% of firms claimed that they were unconfident they would get the skills in the next decade. There are multiple factors contributing to the reduced uncertainty with an extended timeframe; one factor is the pace of technological innovation in this space. Much may rely on how responsive further and higher education courses are to innovations in frameworks, technologies and tools used for development. More reliance would be placed in continued up-skilling and retraining of current employees over the next decade and beyond.

Actions that businesses are taking to tackle skills shortages

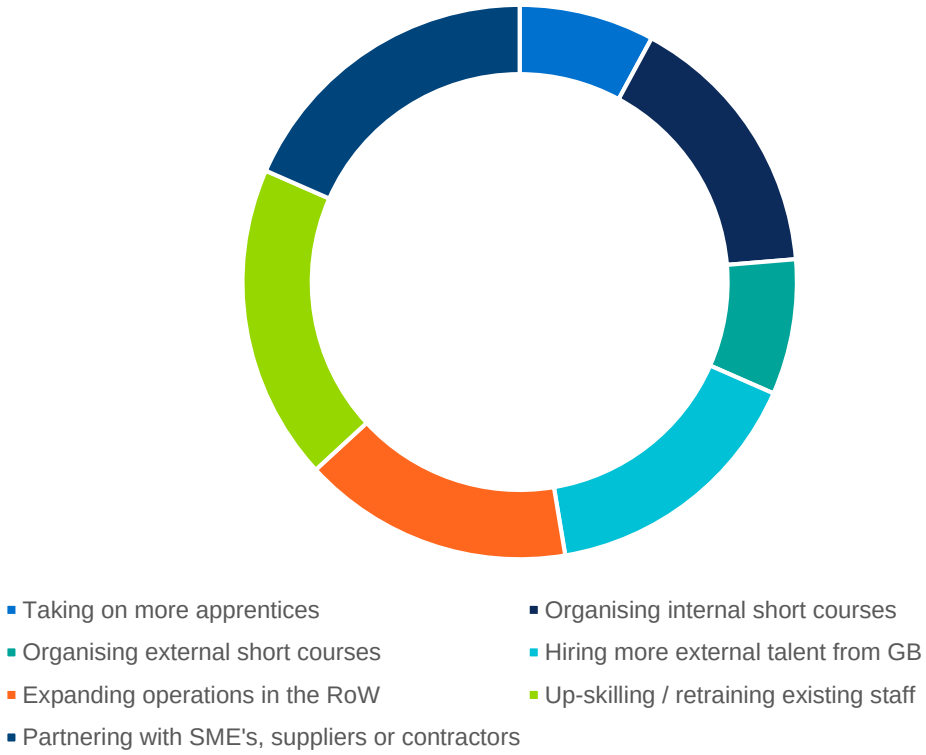
Over 57% of businesses have been taking actions to address their digital skills needs. Note that the proactivity of firms correlates with the size of the firm and potentially the resources that they have at their expense. Both large and medium-sized firms would organise internal short courses for training and large firms especially would partner with SME's, suppliers or contractors to work on projects on a temporary basis where there did not exist labour internally.

In addition, many firms have engaged with the Department for the Economy and Invest NI to run Assured Skills Academies that create new labour in areas such as data analytics, DevOps, cloud computing, cyber security and general software development. Although reportedly slow to mobilise, companies surveyed found that the content, delivery and output has been good and useful to the organisations that have engaged.

Importantly, it is important to note that companies have also reported that they have had to turn down several contracts and work opportunities due to the fact that they do not have the people to scale their businesses. This is a significant barrier to growth for industry in Northern Ireland.

Over eighty-five percent of firms either agreed or strongly agreed that it was important for Government to take action to address digital skills gaps. Moreover, although firms were investing in their employees, most felt that they were not doing enough to combat the digital skills shortages; and would if there existed government support. Over 80% of businesses strongly agreed that it is important that there is frequent interaction between industry and governmental organisations on aspects such as FDI strategy.

Figure 20. What Northern Irish digital and technology companies are doing to tackle their digital skills issues



Establish effective two-way communication channels between industry, education and Government.

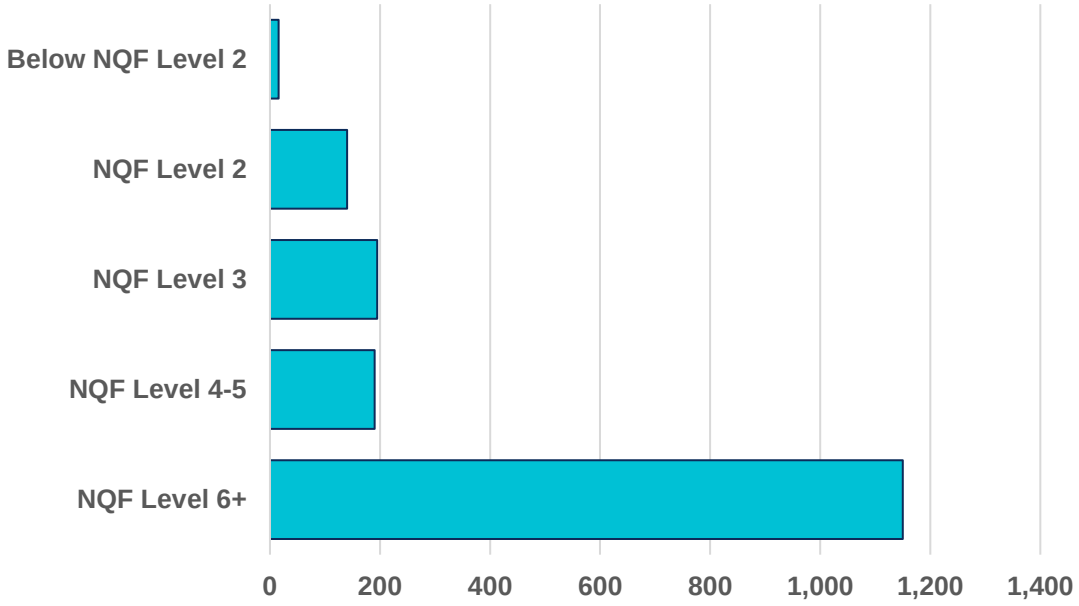
- Establish Advisory Council between IT industry & Invest NI that focuses on clarifying FDI strategy and employment dynamics for Northern Ireland.
- Industry to communicate potential reasons for reported high undergraduate unemployment in the IT sector and articulate what exact skills are required from Level 5, 6, and 7 education.

Measuring the skills gap

The fundamental issue is that as the demand of individuals with digital skills has risen the supply of these skills has still not caught up and has, at best, flatlined since 2014. Figure 21 shows the net requirement for information & communication sector at each NQF level. Altogether, approximately 1,740 people per year are required for the replacement and growth of information and communication sector.

As seen in Figure 17 (Section 4.5), the average supply to the market from 2013—2018 is 1,560; a total of 180 short of what the information and communication sector demands. The shortage noted here aligns well with the Skills Barometer findings.

Figure 21. Net requirement for Information & Communication sector at each NQF level, 2019



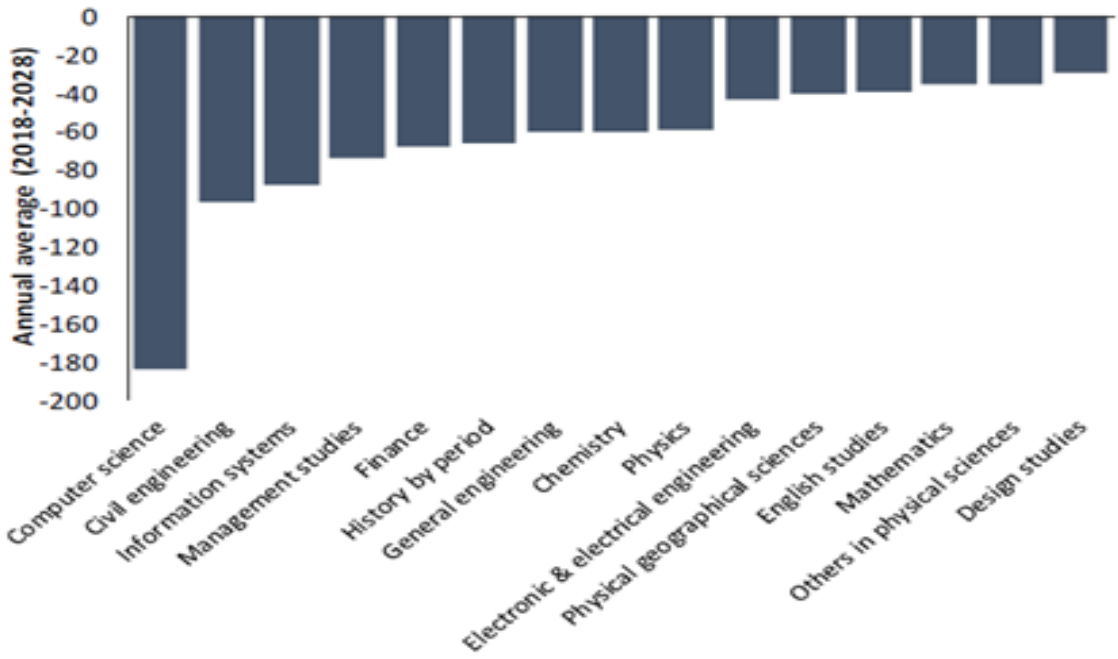
Source. Department for the Economy

In 2019, the Department for the Economy commissioned Ulster University Economic Policy Centre (UUEPC) to develop a Skills Barometer. The barometer is an attempt to accurately identify people and skills gaps within the economy. It specifically highlights key areas that ought to be addressed by policy. The development of the skills barometer involves the use of a model to estimate the future skills needs and gaps by qualification level, subject area, and sector.

The Information & Communication sector plays a significant part in the most recent skills barometer, and specifically the people and skills required to support it. The skills barometer estimates that between 2018 and 2028 there will be an annual deficit of approximately 185 individuals from computer science. Indeed, computer science is projected to be by far the most undersupplied subject area which is largely reflective of the continually increasing growth of the information & communication sector.

Note, however, that there are some caveats to our analysis which is likely underestimating the size of the skills gap. First, and as noted when defining the digital economy, digital skills are required throughout the economy and are not solely required in the domain of the information and communication sector. Conservatively, an extra 50% of the demand is outside of the information and communication sector.

Figure 22. Top 15 skills annual average undersupply (by 2-digit JACS)



Source. UUEPC skills barometer

Second, the overall entry supply noted in Section 4.5 is based on the number of entry undergraduates, postgraduates, academy students and apprentices – it does not consider the drop-out rate, which varies depending on the student, but can be as large as 19% for undergraduate students. Therefore, the entry supply is likely lower than what is provided by the data.

Third, the overall entry supply data also doesn't consider the migration of students after they finish their course. Currently, 21% of students leave Northern Ireland after graduating from undergraduate or postgraduate degrees, moving to economic hubs such as London, Edinburgh, or Dublin, or returning to their country of origin if they are non-NI students.

Fourth, the demand schedule does not incorporate the range of start-ups that would have a greater potential to hire with more stable wages nor does it include firms who could expand if more labour was available. Finally, the unemployment rate in the sector is relatively high; currently reported at around 7% for graduates with ICT qualifications.

Overall, it is with confidence that the skills gap recorded above of 180—185 per year is therefore underestimated. More accurately**, the skills gap can be estimated at approximately 325 per year for the digital economy**. The cost of persistent mismatches and shortages are substantial. For instance, competitiveness can be eroded as skills mismatches constrain labour productivity due to misallocation of workers to jobs.

Communication and Coordination

Forums and working groups need to be rationalised throughout the software sector to remove duplication of effort and increase the harmonisation of message. A communication structure must be created to include the industry as a whole.

A new structure for communication

A proposed communication structure is advocated that includes:

- Two large employers' representatives,
- Two medium-sized employers' representatives,
- Two small employers' representatives, and
- Two representatives for micro and entrepreneurial firms.

These industry representatives will have two-year terms and act as conduits of communication between the industry as a whole, educational stakeholders, and government.

The representatives will meet with institutions from Higher, Further, and post-Primary education, Permanent Secretaries or Ministers of the Department for the Economy and Department of Education, and representatives from Invest NI, quarterly (every 3 months) to review and inform the policies to be taken to better equalise the demand and supply of people and appropriate skills.

Overview of Policy Recommendations

A full list of policy recommendations is given below.

	Challenge	Action	Lead responsibility
1	Understand the current and projected demand for digital skills.	Invest NI, the Department for the Economy and industry to meet twice annually regarding FDI strategy, investments, and the attraction in technology companies.	CBI NI, Invest NI, and the Department for the Economy
2		The CBI will seek support from Invest NI to gather information on the pipeline of the demand-side to better understand the range of future skills demands required in the sector.	CBI NI, Invest NI and Industry
3		An analysis on skills demanded by the IT industry to be updated, reviewed and published annually by the Department for the Economy.	Department for the Economy
4		Industry must be adequately consulted with regards the strategic investment into the development of innovation clusters. Consideration must be made for the pipeline of digital skills and the overall long-run market consequences of investing heavily in technological sub-sectors.	Department for the Economy and Invest NI
5	Support the supply of digital skills	Educational institutions and industry to work with each other to better understand the skill sets that are required by industry, and what is taught at NFQ Level's 5 and 6.	Industry, Higher Education and Further Education

6		The provision of financial support in the immediate term for postgraduate taught courses in computer science and relevant technical fields, specifically focussing on conversion courses and specialist programmes in cyber security, statistics, analytics, and artificial intelligence.	Department for the Economy
7		Higher Education institutions to be advised that future funding is to be prioritised on opening more undergraduate places in computer science, software development, and related fields. Separate funding for resourcing to be seriously reviewed.	Department for the Economy
8		Sub-group to be established to review higher-level apprenticeships uptake and address issues presented by industry such as billable hours, perverse incentives, and provide more accessibility to smaller firms. Consider measures such as, the subsidisation of wages for first year apprentices (particularly for those in SMEs) until they have gained enough experience to be billable or productive in the company, or to centralise first-year HLA study programmes.	Department for the Economy and Invest NI
9		Incentivise those who are economically inactive, unemployed, or those currently in a job to engage in distance-based learning programmes that teach digital skills. Incentivisation could come in the	Department for Communities, Department for the Economy

		form of subsidising course fees for students unable to pay.	
10		Industry, with government support, to establish a centralised programme to streamline and harmonise graduate and apprentice onboarding.	Industry
11		The development of a Programme of Study for ICT education at Key Stage 3 level.	Department of Education
12		Issue a call for further digital skills retraining / upskilling courses, targeting the unemployed and those wishing to return to the workforce after inactivity with flexible working opportunities.	Department for Communities, Department for the Economy
13		Department for the Economy to work with industry to identify why initiatives geared for sector attractiveness are not effective and what alternatives can be supported or established.	Department for the Economy, Industry
14		Industry to work together on establishing a framework of best practices for effective work experience / shadowing and internships.	Industry, Invest NI, Department for the Economy
15		Universities and FE colleges to work towards integrating at least one computer science module into teacher training courses.	Educational institutions

16		Industry along with schools and the Department of Education to facilitate increased continual personal development for teachers.	Department of Education, Industry
17		Universities and colleges to share aggregate data regarding where Computer Science (or related) students work (company, industry, country) after graduating.	Educational Institutions
18		Industry, educational institutions and government to consider a rationalisation of and removal of duplication in working groups and forums. A new structure of engagement must be considered that centralises communication.	Department for the Economy, Industry
19		Advertising campaign to address young people and parents regarding career opportunities and pathways.	Department of Education, Department for the Economy, Invest NI
		Improvements to Careers Advice for the Digital Economy	Department of Education, Department for the Economy
20		Develop an online portal, like Tech/Life Ireland, that promotes opportunities and the attractiveness of living and working in Northern Ireland.	Invest NI

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