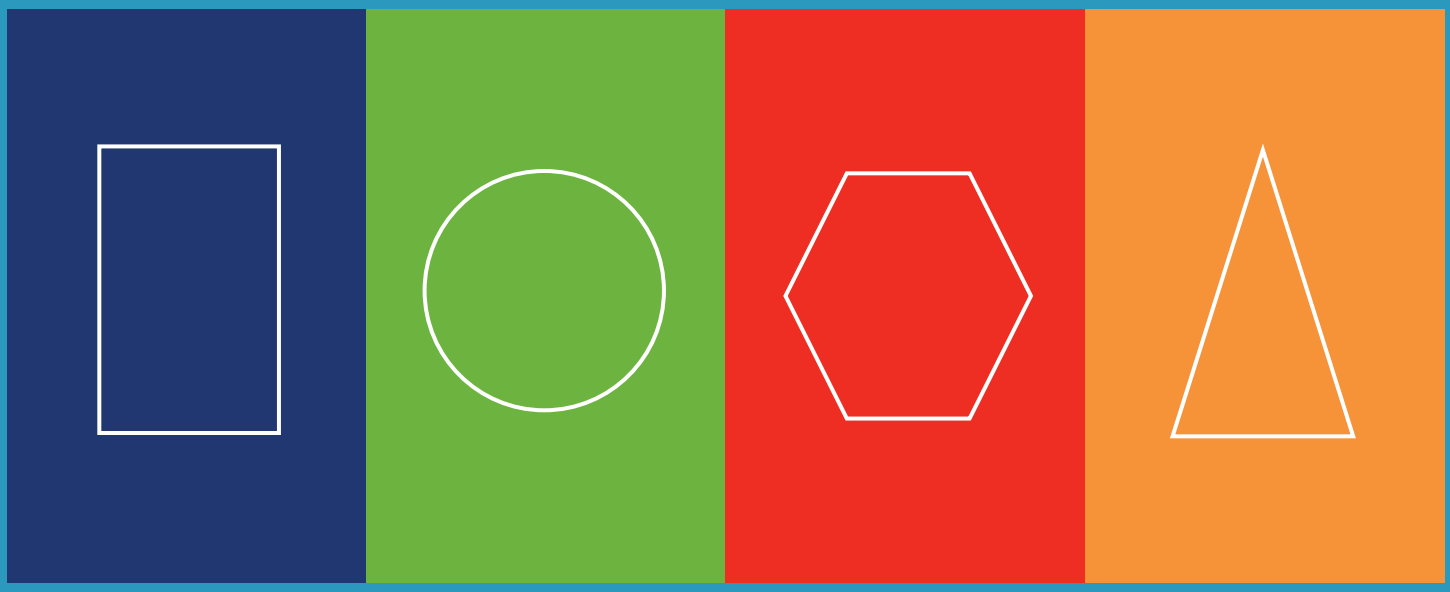

Digital Transformation: Assessing the Impact of Digitalisation on Ireland's Workforce

December 2018

National Skills Council

Expert Group on
Future Skills Needs

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The EGFSN Secretariat would also like to acknowledge IDC UK Ltd. whose work included the literature review, the economic modelling, and the undertaking of interviews with key informants, as well as the integration of the various research elements into the final report.

Introduction to the Expert Group on Future Skills Needs

The Expert Group on Future Skills Needs (EGFSN) advises the Irish Government on the current and future skills needs of the economy and on other labour market issues that impact on Ireland's enterprise and employment growth. It has a central role in ensuring that labour market needs for skilled workers are anticipated and met.

Specifically, the EGFSN:

- Carries out research, analysis and horizon scanning in relation to emerging skills requirements at thematic and sectoral levels. Steering Groups comprising of experts from relevant enterprise sectors and the education and training sector may oversee sectoral research studies to be undertaken or commissioned by the EGFSN. Drawing on statistical input and analysis from the SLMRU and consultation with the enterprise/education experts as part of the study, draft reports setting out the projected needs are prepared by the EGFSN.

- Engages with the HEA, SOLAS, QQI, the Regional Education Fora, and education and training providers in the course of its research.

- Engages with DES, HEA, SOLAS and other relevant bodies to produce agreed action plans to address the skills needs identified.

- Submits the findings of its research and agreed Action Plans to the National Skills Council prior to publication.

- Disseminates its findings to the Regional Skills Fora and other relevant groups.

The Strategic Policy Division within the Department of Business, Enterprise and Innovation provides the EGFSN with research and analysis support.

Foreword

Digital transformation is a key component to business success. For a business to succeed it needs to constantly evolve, adding new products or services to respond to changes in the market. The adoption of technology allows businesses to do this and to perform core processes faster with a higher quality and a lower cost. Technology not only allows firms to repurpose their existing offering, it also allows firms to diversify into new areas. This results in the potential to create new jobs within firms and the overall economy.

Over recent years, numerous studies have been published predicting the potential impact of new technologies on a global scale. The goal of this report was to understand what we can expect in the Irish context. Our research shows us that it is projected that the Irish economy will perform strongly over the next five years. This means that hypothetical job losses resulting from digitalisation will be offset by growth in the economy. Based on our findings, it is expected that the majority of sectors will have more employees in 2023 than they do currently, notwithstanding the unpredictable international trade environment.

However, this does not mean that we can be complacent. The report makes clear that while there may be some exaggerated predictions on the impact of digitisation on job losses, there will be significant disruption in terms of the job roles and tasks performed by individuals. It also argues that increased career changes and workforce transitions will be a feature of the future. To ensure that these transitions are smooth, the continuous engagement of the workforce in education will be vital. Constant reskilling and upskilling will be required from workers in order to develop skills that are complementary to new technologies. This further underlines both the importance of the continued development of lifelong learning systems and the broader awareness surrounding the opportunities available. In this regard, the EGFSN hopes that the report will make a useful contribution to the development of related Government initiatives such as Future Jobs and the National Digital Strategy.

On behalf of the EGFSN I would like to thank all of the contributors to this report who so generously gave us their time and expertise. I would also like to express my thanks to the members of the project Steering Group for their insights and support in finalising the report. Finally, I would like to thank the EGFSN Secretariat, within the Department of Business, Enterprise and Innovation for managing and leading the study to a successful conclusion.

Tony Donohoe

Chairperson, Expert Group on Future Skills Needs

Executive Summary

Key Findings

This study assesses the impact that the adoption of digital technologies will have on sectors, occupations and regions in Ireland over the years 2018 to 2023. These impacts present new challenges to both public and private enterprises and the workforce. Specifically, it has found that:

- One in three jobs in Ireland are at high risk (a probability greater than 70%) of being disrupted by the adoption of digital technologies. Much of the disruption, however, will result in changes to job roles and tasks performed by individuals rather than job losses. While it is expected that the number of jobs lost will increase steadily over the next decade, this report estimates that disruption from the adoption of digital technologies over the next five years will lead to a hypothetical loss of 46,000 jobs when compared to growth predictions for jobs without accounting for the adoption of digital technologies.
- However, strong overall growth predicted for the economy should generate enough new jobs to replace those lost. The majority of sectors in the Irish economy are expected to be employing more people in 2023 than they did in 2018, with overall employment at levels never witnessed before in Ireland. The exceptions to this are the Real Estate and Financial Services sectors.
- Sectors most at risk are those normally associated with repetitive, manual tasks that can be replaced by automation, but the risk is not just limited to these. The sectors most at risk include Agriculture; Retail, Transport and Hospitality; and Manufacturing.
- The jobs at highest risk of displacement by digital technologies include many elementary, low-skilled occupations, but also include several sales and customer service occupations that can be replaced through a combination of chat bots and robotic process automation (RPA).
- The potential impact of automation will be felt by those with lower levels of educational attainment. Changes to the way end users want to consume education and training means that education and training providers need to do more to enable access to provision and employers need to support workers to upskill and reskill.
- At a regional level, Dublin is the least at risk from automation, while the Midlands and Border regions are most at risk.
- There will be opportunities for many people to upskill within their current jobs. As some tasks become automated, employees will be trained to take on new tasks or, in some cases, new job roles. A small number of interviews carried out as part of this project with employees whose employers have already invested in digitalisation/automation show that this upskilling process is already underway and that for most employees interviewed the experience is a positive one.
- Those people who do lose their jobs will have to retrain for new roles and this will require engagement from different stakeholders. It will be important for public bodies to work with employers to identify where job losses are likely to happen in the first instance. Thereafter, they will need to work with those employees to help them retrain and reskill for employment in other environments.
- In the coming years, there will be a need for all stakeholders to prepare for an increasingly automated world, as it is likely that job roles may change more quickly than in the past, and individuals may have many different jobs during their lives. This will have implications for the

types of skills people are taught during their years of formal education, but will also make the requirement for ongoing education and training more necessary. The concept of lifelong learning where each individual has an education and training programme they follow throughout their career will become more of an imperative. There are already programmes and initiatives in place in Ireland, both in Higher Education and Further Education and Training- for example Springboard+, which provides retraining and reskilling opportunities in areas such as high-end manufacturing, and the SOLAS 2018-2021 further education and training policy framework for employee development opportunities in Ireland.

- The Government has taken steps to address the challenges that digitalisation and automation will present in the coming years. It is working to identify changes that will need to be made to the education system, such as the soft skills that will need to be taught at primary level to prepare children for a world in which the ability to communicate and collaborate will be even more important. The need for all workers to have digital skills has been recognised and is being addressed. All of these measures will help to prepare the students and workers of today for employment in later years when the biggest impact on jobs is expected to be felt.

Stakeholder Summary

The research with stakeholders in a range of industry sectors and representative bodies provided an insight into the current stage of digitalisation/automation in Ireland, how it will proceed in the coming years, the extent to which jobs will likely be impacted and what the timescale for this will be. It should be noted that this input was based on a small sample size of 15 in-depth interviews.

The key findings are:

- The adoption of digitalisation/automation is happening gradually in Ireland and this slow but steady progress is expected to continue.
- As a key location for the development of digital technologies Ireland is already benefitting greatly from the global roll-out of digital transformation.
- Most respondents expect the biggest jobs impact in their sector will be between 2023 and 2030.
- The main risk will be for people in low-skilled occupations.
- Respondents expressed confidence that in the longer-term their sector would experience a small net loss of jobs or a balanced outcome.
- Retraining and reskilling will be required to minimise the negative impact of digitalisation/automation on employment and there will be a role for many stakeholders to play in this.
- There was acknowledgement that Government initiatives are already underway in a number of areas including a greater emphasis on teaching soft skills in the education system, the promotion of life-long learning for all employees, and retraining and reskilling programmes. These are already helping to prepare the country for the challenges that increased digitalisation/automation will present.

Key Implications

Following quantitative and qualitative analysis this report has identified the following five key areas of focus for Ireland moving forward:

- **Vision.** Clear goals should be set by Government that cover common enablers that are necessary to ensure a sound infrastructure is available for enterprises to build on.
- **Collaboration.** Close collaboration between state and non-state bodies will help Ireland respond to the challenges imposed on the workforce by digitalisation. Performance management and other governance processes should allow for collaboration across government departments and with the broader ecosystem.
- **Data.** Information is becoming increasingly important to enterprises. Government agencies should continue to focus on working with industry to identify where data can help drive business development.
- **Technology.** The increasing number and variety of connected devices and technologies means enterprises know more about their environment than ever before. The success of enterprise will result from how they interpret and use the data provided to them by new technologies and how they respond to the emergence of disruptive technologies.
- **Skills.** Enterprises have recognised that to be successful in their adoption of digital technologies, they will need a diverse set of skills, in addition to technical skills and high levels of IT literacy. The following skills were identified as particularly important:
    - **Leadership.** Innovative thinking on how technology can be used to improve processes and business activities, which encompasses skills such as emotional intelligence and strategic thinking.
    - **Interpersonal skills.** This involves change management and content presentation, facilitation and conflict resolution. These skills are vital in implementing technology while maintaining a positive and productive culture within an organisation.
    - **Business skills.** The skills needed to enhance project manager effectiveness, or the business analysis skills to understand new approaches to programme management such as design thinking and the ability then to influence stakeholders, business partners and those in other organisational silos.

As evidenced in the following table, much is already underway in preparation for the future demands resulting from the increased adoption of digital technologies. Whilst it is apparent that systems are functioning well in respect to our current economic climate, it is important to ensure they can deal with the ongoing future challenges arising from the increased adoption of digital technologies.

Current Policies and Initiatives in Place Addressing Five Key Areas of Focus

Key Areas	Policies and Initiatives Addressing Areas
Vision	National Digital Strategy
Collaboration	R&D Technology Centres/Gateways Innovation Partnerships SFI Industry Fellowships
Data	National Data Infrastructure
Technology	Disruptive Technologies Innovation Fund Industry 4.0 Strategy
Skills	National Skills Strategy 2025 ICT Action Plan National Digital Strategy for Schools Skills for Growth Initiative Spotlight on Skills Skillnet Ireland Springboard+ EXPLORE

It is crucial that the systems in place can both deal with the scale of the challenge ahead and have the capacity to respond to the challenges in a timely and effective manner. Both the Department of Business, Enterprise and Innovation and the Department of Education and Skills, and their agencies, have roles to play to ensure that the opportunities arising from the adoption of digital technologies can be maximised and the negative effects minimised.

The Department of Business, Enterprise and Innovation, through its agencies of EI, IDA and SFI must facilitate enterprises to be in a position to take advantage of the opportunities emerging from the adoption of digital technologies. The Department of Education and Skills and its bodies should consider the current actions in place in relevant policies and strategy documents to ensure that they can be targeted and tailored at those facing redundancies as a result of the increased adoption of digital technologies.

Chapter 1: Introduction

The adoption of digital technologies and its impact on the workforce is a key subject across both the public and private sectors. While there is a lack of statistical evidence of its impact on jobs, people have long been concerned that the adoption of technology could make their job redundant. However, even though digital technology is emerging in many industries as the major driver for change in occupations, its adoption has yet to have any substantial impact on employment levels.

The emergence and uptake of digital technologies such as automation, advanced analytics and artificial intelligence may threaten certain occupations, but the horizon for their impact is unclear. At the same time, these technologies are stimulating the creation of new occupations and new industry subsegments, as well as improving the overall productivity of the workforce, which in turn helps to lift the overall economic wellbeing of populations.

With this in mind, Ireland is posed with the following questions:

- What do these trends mean for Ireland?
- Is there evidence that specific occupations are at risk or are already being lost due to the uptake of digital technology?
- How are enterprises reacting to the effects of technology adoption? And, what does this mean for various sectors of the economy?

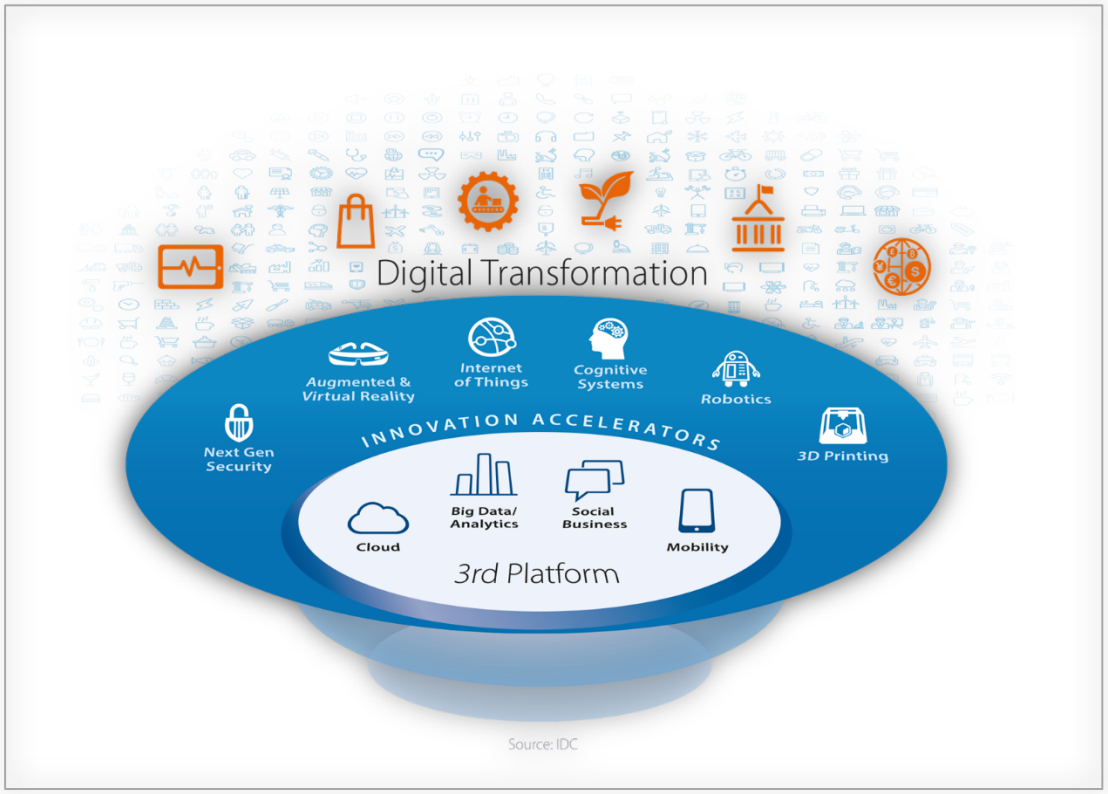
The goals of this study are to provide policy-makers with a more granular picture of the projected impact of digital technologies in Ireland and to highlight the opportunities and challenges this will present.

This report considers the main digital technologies and their potential impact on the workforce across Ireland. Previous studies have focused primarily on the impact of automation, which is understandable given the potential for replacing repetitive, manual tasks. However, it is important to explore the impact of new and emerging technologies such as the Internet of Things (IoT), Artificial Intelligence (AI) and headless-user-interfaces (chat bots).

The relationship between the adoption of technology and its impact on labour is not straightforward. Since the industrial revolution technology has tended to improve productivity, which in turn has led to higher wages. It has also changed the nature of work, altering specific tasks and the skills required of the workforce. While technology has historically been a catalyst for change, it has not led to mass unemployment. This is due to a wide set of factors, including a company's appetite for risk towards R&D, the ability of employees to move to higher value roles within their organisation, the availability of skilled labour and government policies. However, concerns remain that the adoption of new digital technologies will accelerate the onset of unemployment.

The worldwide ICT market is forecast to grow by a compound annual growth rate (CAGR) of 3% in the period from 2016 to 2021. However, below this top line number are stronger growth markets for emerging technologies, which are driving fundamental change to businesses and consumers across the world. These Innovation Accelerators (Figure 1), include cognitive systems and AI, robotics, IoT, 3D printing, augmented and virtual reality, and next-generation security. A commonality between these diverse technologies is that they are enabled by the 3rd Platform of cloud, big data/analytics, mobility and social media. The previous platforms were client/server (2nd Platform) and mainframe (1st Platform).

Figure 1: Emerging Technology Trends



Source: IDC, 2018

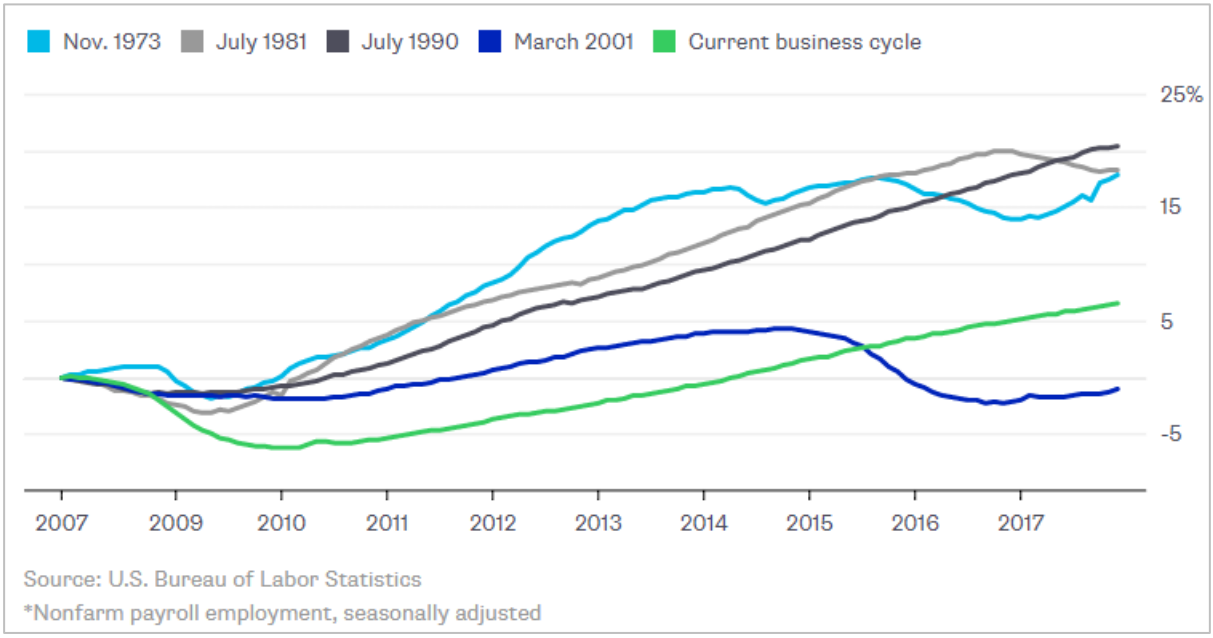
The possibilities of how to deploy these new technologies to change business models, innovate products and services, and radically improve customer experiences are only just emerging. But this does not mean that organisations across the world are not thinking about what they can do for their businesses. Research shows 84% of the CEOs of the FT500 companies already have digital transformation at the centre of their corporate strategy.

It could be argued that a wave of ICT coming to market is nothing new — but what is different is how organisations are applying these technologies. Technology is no longer confined to the IT department, and neither are the skills required to work with it. This places an emphasis on 'hybrid' skills — people need to understand how to navigate both business and technology.

Chapter 2: The Impact of Technology on Employment in Ireland

The longstanding debate about how technology affects the labour market and what policy-makers should do about it has been given increasing impetus in recent years. An immediate concern is the relatively slow increase in employment in larger mature economies after the 2007 recession (often called the "jobless recovery") compared to previous recessions. To illustrate this phenomenon, Figure 2 shows the growth of employment in the United States in the 10 years following each recession since 1973.

Figure 2: Employment Growth 10 Years after Recession Start, Comparing Five Recessions, United States, 2018 (Bloomberg)



Source: Employment Growth 10 Years after Recession Start, Comparing Five Recessions, United States, 2018 (Bloomberg)

As this data shows, the increase in employment in the United States has been extremely slow after the past two recessions. The reasons for this are much debated, often with cause and effect, and second/third order effects intertwined. They range from inadequate demand side stimulus to various macro and micro supply side factors. These include the long-term effects of the former communist bloc, China and India entering the global labour force, population demographics in mature markets, government regulation, monopoly and market concentration and technology.

Fears over technology depleting jobs are far from new. However, in the 19th and 20th century, the number of jobs created in the services sector (which typically were harder to automate) was higher than the jobs lost in the agricultural and manufacturing sectors. The current concern is that technology now has the potential to automate many tasks, job roles and even sectors of the economy, particularly in services, where most people in modern economies are employed. Of focus

in this debate is a paper by Frey and Osborne[1] (F&O) which asked experts to estimate the potential for automation of selected occupations and drew the conclusion that 47% of employees in the US were working in sectors that had the potential to be automated. That paper has been extended to other countries and criticised for presenting an overly simplistic view of the tasks carried out by workers and how likely it is that technologies will be applied to these occupations given cultural and legal conditions.

This EGFSN study looks at the impact of technology on the labour market in Ireland over the next five years. It considers whether the next wave of digitalisation will cause fundamental changes in roles across sectors of the economy and in future skills needs. Another point of focus will be the implications for policy going forward to ensure that the transition from the current to the future workforce is managed effectively.

A set of emerging and rapidly developing technologies termed *Innovation Accelerators*, are critical to the next wave of digitalisation. The six technologies, detailed further in Chapter 3, are:

- Internet of Things (IoT)
- Cognitive Computing and Artificial Intelligence (AI)
- 3D printing
- Augmented Reality (AR) and Virtual Reality (VR)
- Robotics
- Blockchain

Some of these technologies are expected to grow rapidly over the next five years. Investment in cognitive/AI in Western Europe is forecast to rise from approximately €850 million in 2016 to €5.4 billion in 2021, with high growth in sectors such as Healthcare (65% CAGR) and Retail (60% CAGR).[2] The impact of these technologies on the labour market can be grouped into the following areas:

1. In the growth or decline in jobs in sectors of the economy. A clear example is publishing- data from the US has shown the decline of employment in newspaper publishing from approximately 450,000 people in 1990 to 185,000 in 2016.[3] In contrast, employment in internet publishing and broadcast has increased from 30,000 people in 1990 to nearly 200,000 in 2016. This EGFSN study aims to identify how innovation accelerators might affect different sectors. For example, it might be hypothesised that greater adoption of sensors and other IoT solutions for digital signage in the Retail sector will reduce the number of jobs in that sector as fewer field service engineers are needed.

[1]Frey, Carl Bendikt and Osborne, Michael A., 'The Future of Employment: How susceptible are jobs to computerisation?' Oxford Martin School (2013). Available from: https://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf
[2] IDC estimates
[3]Bureau of Labor Statistics, U.S. Department of Labor, *The Economics Daily*, Employment trends in newspaper publishing and other media, 1990–2016. Available from: https://www.bls.gov/opub/ted/2016/employment-trends-in-newspaper-publishing-and-other-media-1990-2016.htm

2. In the growth or decline of employment in occupational roles both within and across sectors. For instance, it might be that the levelling off in employment in accountants and auditors as a proportion of the labour force seen in the US from 1990–2000 is a result of the automation and digitisation of tasks which used to be carried out by clerks.[4]
3. In the skills needed for individuals to remain competitive in the labour market and for increased productivity and competitiveness in the economy. Certain skills are more likely to be relevant in the next five years than others, and a key priority for policy-makers is to ensure that the workforce possess those skills. The skills needed to be successful within enterprises that build their business around these technologies are considered later in this report.
4. The shift towards more value-added activities and the pace of technology convergence driving digital transformation and new business opportunities is conceptualised in the 3rd Platform technologies model (the convergence of mobile, cloud, big data, and social technologies) and innovation accelerators (IoT, AI and cognitive computing, robotics, 3D printing and additive manufacturing, blockchain).

[4] Ian D. Wyatt and Daniel E. Hecker, 'Occupational changes during the 20th century' *Monthly Labor Review* March 2006 Available from: https://www.bls.gov/mlr/2006/03/art3full.pdf

Chapter 3: Digital Transformation and the Role of Innovation Accelerators

As previously stated, the worldwide ICT market is forecast to grow by a CAGR of 3% in the period from 2016 to 2021, with a strong growth market for emerging technologies sitting beneath this figure. The key trend that is driving the implementation of these technologies is digital transformation.

3.1 Digital Transformation

Digital transformation has been a strong theme in both business and IT over the past five years — and often is a term mistakenly used for almost any kind of new technology adoption. True digital transformation is the transformation of a business, underpinned and enabled by digital technology, guided by two key principles. One is that the adoption of technology must be about transforming the business and not about the technology itself. The other is that true digital business transformation is an ongoing process that requires cultural change. Due to the speed of technological change, treating digital transformation as a one-off project would mean that in a brief time, the organisation would once again be behind competitors and peers in the market.

The past decade has seen a new wave of information and communications technology 'coming of age' and being adopted widely in organisations in Europe and worldwide. These 3rd Platform technologies are now fundamental to organisations' IT environments, and there is a surge of interest in how to use them.

External considerations, such as improving customer interactions and developing new products and services, are currently driving the majority of digital transformation strategies. This does not mean that organisations are downplaying the importance of digitising internal processes and operations. The past few years of experimentation has shown that without also addressing the underlying processes that underpin customer interactions (such as order, payment, fulfilment and return processes) even innovative digital customer experience interfaces will not be successful.

Some of the key factors for successful digital transformation are those that can be found in any ICT project: setting the strategy, designing the solution, and planning and implementing the technology. However, a strong understanding of the business and required business process changes are also fundamental in digital transformation, which often leads to the development of new business models.

3.2 Innovation Accelerators — Disruptive Digital Technologies

The possibilities of how to deploy the technologies termed Innovation Accelerators to change business models, innovate products and services and radically improve customer experiences are only just emerging. However, this does not mean that organisations across the world are not thinking about what they can do for their businesses.

Irish organisations are already investigating in these technologies, but implementation will be gradual, with some sectors leading the way as others follow. While their adoption is expected to lead to job losses over a longer period, most of these technologies will not have a significant impact on jobs during the five-year timeline (2018–2023) which is the primary focus of this report. Nevertheless, one technology is expected to lead to job losses in the near term. It falls under the broad heading of artificial intelligence.

3.2.1 Artificial Intelligence/Cognitive Systems

Artificial Intelligence and Cognitive System (AI/CS) technologies started to take centre stage in the past twelve months across the globe and continue to attract new investments and attention from all sectors. The AI/CS market is still nascent, but it has immense potential.

AI/CS is not a new technology or topic, but the availability of more flexible, scalable and affordable computing power, combined with analytics and exploding data volumes has created an optimum environment for AI/CS to emerge as key technologies of the future. AI/CS is a set of technologies that use machine learning, speech analytics, natural language processing, machine vision and analytics to process data to make informed decisions or recommendations. These platforms facilitate the development of intelligent, advisory and AI-enabled applications, including intelligent assistants that may mimic human cognitive abilities. The technology components of AI software platforms include text analytics, rich media analytics (such as audio, video and image), tagging, searching, machine learning, categorisation, clustering, hypothesis generation, question answering, visualisation, filtering, alerting and navigation.

AI/CS enables the discovery, use and collaboration of data in analysis and decision-making. Machine learning enables machines to learn from experience on their own. These algorithms are capable of learning from examples and making predictions based on that. This will enable computers to learn, discover patterns, predict outcomes and improve automatically without explicit programming. Most of the leading technology companies, such as IBM, Google and Microsoft are using machine learning inside their cognitive platforms. Deep learning and re-enforcement learning, which are the subsets of machine learning, are gaining higher importance with the recent advancements in AI/CS research. Machine learning is expected to be a core part of most AI/CS solutions in the future.

AI/CS technologies and platforms will continue to expand rapidly in the coming years. Developing and broadening technology capabilities such as conversational AI, image, audio and video analytics, deep learning and hypothesis generation would be among the key priorities for technology vendors. There is also a growing trend of integrating AI/CS systems with enterprise collaboration tools to add new capabilities and to make these tools more intelligent. This trend will get stronger in the next five years and will lead to massive reengineering of the workplace to make it more responsive, agile and enable it to facilitate data-driven decision-making across business functions.

AI/CS technologies are poised to transform the way businesses are operating today. It will free the knowledge worker from mundane or low-value tasks to focus on higher value jobs. The ability of

AI/CS systems to process structured and unstructured data inputs makes its applications broader than most of its peer technologies. Companies have already started to engage AI bots at customer touch points to handle customer queries quickly and efficiently. These AI systems with natural language processing and generation capability, can respond to customers via voice/text channels just like its human counterpart. This will transform the way enterprises interact and engage with customers and deliver services to its end users in the future.

Only a minority of enterprises have begun to explore the potential of AI/CS technologies today, but this is expected to change in the near future as many organisations are currently in the planning or evaluation stages. Potential use cases for AI/CS technologies are broad and vary across different industries. The use cases that attracted more attention and investment in Western Europe in 2017 include sales process recommendation and automation, fraud analysis and detection, quality management systems, automated threat intelligence and prevention, and IT automation. These five use cases accounted for more than 50% of the AI/CS spending in 2017.

Overall, AI/CS technologies have started to make their mark as many organisations seek new ways to reduce the cost to serve and time to market, and improve operational efficiency. Worldwide spending on cognitive and AI systems will reach $19.1 billion in 2018, an increase of 54.2% over 2017. With industries investing aggressively in projects that utilise cognitive/AI software capabilities, it is forecast that cognitive and AI spending will grow to $52.2 billion in 2021 and achieve a compound annual growth rate of 46.2% over the 2016–2021 forecast period.[5]

3.2.2 Application Automation/Robotic Process Automation

One component of AI/CS which is having a major impact on the automation of job roles is robotic process automation (RPA). The adoption of this technology is expected to have some impact on jobs in Ireland within the 2018–2023 timescale. The Institute for Robotic Process Automation defines RPA as the application of technology that allows employees in a company to configure computer software or a "robot" to capture and interpret existing applications for processing a transaction, manipulating data, triggering responses and communicating with other digital systems.

RPA can further be defined as a software code that automates and assigns standardised, rules-based, repetitive and high-volume processes involving several interoperable systems — which were traditionally executed by humans — to a robot. To a certain extent, RPA can be described as human-defined decision-making, where rules are created by humans, with these rules determining the triggers, process flows and activities to complete a business process.

The concept of process automation is not a new development as it has existed in the distant past. However, RPA does offer distinctly advanced features, including system-agnostic capability, centralised user management, detailed audit trails and workforce management. Its potential to deliver meaningful customer support, improved decision-making and valuable customer insights

[5] IDC Estimates

when coalesced with cognitive technologies (which alongside artificial intelligence completes the continuum of intelligent automation mentioned above) will create growing demand from organisations in a range of industries.

Several characteristics of business processes make specific ones primed for RPA:

- Processes that are repetitive, rule-based, standardised and involve high transaction volumes.
- Processes that include working with several interoperable systems/applications.
- Processes that do not require human-like intelligence or judgment (exception could be made where only parts are automated, and the rest involve human judgment).
- Processes with a timeline of 12–18 months in a stable and controlled environment to achieve positive returns.

The market for RPA type services continues to grow, it is estimated that the worldwide market for Business Automation and Optimization software will see double-digit growth between 2017 and 2022, growing from $10.2 billion in 2017 to $17.2 billion by 2022, a compound annual growth rate of 11%.[6]

In an Irish context, a slight decline in jobs is expected for back-office functions in the financial services sector, particularly in the 2018–2023 timescale, but not exclusively in those functions; other job roles could also be impacted.[7] However, the use of RPA to automate activities such as the resetting of passwords is more likely to change the tasks performed by IT staff rather than jeopardise their jobs.

3.2.3 Internet of Things

The Internet of Things (IoT) can be defined as a network of uniquely identifiable endpoints (or 'things') that communicate bidirectionally using IP connectivity, typically without human interaction. IoT brings together things, data, processes and people through an integrated ecosystem to make networked connections more relevant by turning information into action. The proliferation of connected devices, maturing cloud IoT platforms and the strong digital transformation trend fuel growth of the IoT market as does the growing number of connected devices and solutions.

The key emerging themes evolving in the IoT market are:

- **Security and openness:** Security and openness are intertwined despite their contradictory nature. The growing adoption of IoT devices and connected solutions by both public and private sector industries will expose their IT systems to new vulnerabilities. These security concerns

[6] IDC estimates
[7] IDC estimates

have not put a break on IoT adoption, but they need to be addressed as an integral part of IoT deployments.

- **Integration and consolidation are central to maximising the value of IoT deployments:** In order to increase efficiency and facilitate innovation, IoT solutions need to be integrated with enterprise processes.
- **The IoT market is moving to a new phase:** The IoT market is maturing and moving from its initial "dash to connect" phase to a more sophisticated phase. Initially, IoT was seen as a tool for data collection only, but this is changing. IoT is now creating transformative opportunities and leading to new value-added services for enterprises. Organisations see IoT as a key enabler of business transformation and an essential component in process optimisation and automation.

The Western European IoT market spending is forecast to grow from $144 billion in 2017 to $264 billion by 2021, a CAGR of 17.2%.[8] On a global basis, the market is expected to grow by a lower 13.1% CAGR over this period to exceed $1,136 billion in 2021. Industry-specific use cases from sectors such as Manufacturing, Utilities and Transportation take a major share of the market. However, the fastest growing markets are consumer IoT (e.g. smart home and personal wellness) and cross-industry solutions (e.g. connected vehicles, smart buildings and security solutions).

Growth is fuelled by the growing adoption of new technologies, coupled with the realisation that IoT adds value to the business, from improving operational efficiency to developing business models. This realisation is leading to IoT raking an important role in digital transformation across Europe. A March 2017 survey of almost 800 European organisations ranks IoT as fourth on their priority list of investments (the top three priorities are cloud, analytics and mobility).

3.2.4 3D Printing

3D printing is a revolutionary technology. While still in early stages of use, it has the prospect of restructuring the economy as prices decline and technology improves. An example of this is in the medical field, where 3D printers can create customised implants, helping doctors and dentists carry out complex operations at the same time. In the past, doctors relied on radiographies to diagnose and operate. Today, scanning organs and printing them allows medical professionals to practice before they perform operations. Similarly, dentists can build 3D models of patient's teeth, allowing them to create detailed fittings that are a better fit in the mouth. This enables them to carry out precise implants and prevent errors.

The 3D printing market is in a period of rapid expansion, and one of the keys to that expansion is growth in the types of build materials that can be used. At the heart of all types of 3D printing are three core materials:

[8] IDC estimates

- **Solid thermoplastics** are the materials used in fused filament (FDM/FFF) 3D printers, which are the most common and widespread, but they typically have the lowest usage rates based on their speed and use cases.
- **Powdered thermoplastics** are used in 3D printing processes such as selective laser sintering (SLS) and selective laser melting (SLM). While a lot fewer 3D printers use these technologies, they tend to be much more production-orientated. Powdered thermoplastics are increasingly used because curing methods using increasingly powerful melting and sintering tools can produce ever-more accurate models and functional parts.
- **Photopolymers** are used in two of the fastest-growing 3D print technologies — stereolithography and PolyJet/MultiJet printing.

Advances in materials are key to take advantage of cost-saving opportunities. Some of the early adopters of 3D printing systems (such as aerospace and automotive) point to the savings they achieved with the capabilities of new, lightweight, high-strength materials. From a user perspective, 3D printers are gaining momentum in manufacturing where fast time to market is important and economies of scale are not achievable.

Enterprises in the fields of aerospace, medical, automotive and jewellery are expected to accelerate the implementation of 3D printer technologies. Parts and products produced by 3D printers will be developed centrally, but manufacturing facilities can be distributed. Some products will be manufactured and delivered faster than traditional manufacturing. The European 3D printing market is forecast to double from $3.6 billion in 2017 to $7.4 in 2022, representing a 15% CAGR.[9]

3.2.5 Blockchain and Distributed Ledger Technologies

Over the past few years, blockchain and Distributed Ledger Technologies (DLT) have gained attention as organisations across a variety of industries look to use DLT as a way to grow revenue, reduce costs, improve business processes and improve financial liquidity.

Distributed ledgers consist of replicated, shared and synchronised data located across multiple systems. Each user can access and verify the integrity of the data in the ledger. They can also add transactions under a specific set of programme rules. This is all done without the need for a central authority to manage and reconcile transaction data, providing efficient, real-time and secure data sharing. It is not important how or where data is stored, but how the consensus is achieved. Hence distributed ledgers are defined by a consensus mechanism between the nodes. The result is an immutable and distributed database of digital assets.

Blockchain, a type of DLT, is a consensus algorithm that contains unchangeable digital data in packages called ‘blocks’. These blocks are formatted in a chain of ongoing blocks that contain details on a series of transactions. The data in each block is cryptographically hashed and linked to

[9] IDC Estimates

the previous block. The cryptographic process ensures the integrity of all data in the overall blockchain. Blockchain enables a distributed network of nodes to continuously reach consensus on content of blocks of data. When this algorithm is deployed, the blocks are ordered to form a constantly growing linear chain, where each block is linked to a previous block and can only be appended to the end of the chain. This gives rise to an immutable log of operations that take place during the deployment. Blockchain is the technology behind Bitcoin.

Today most of the use cases for DLT enable digital transformation in three areas:

- To secure and validate the "state" of the data and metadata part of an ecosystem. Impacting both technologies such as cloud, BDA and security, as well as industries spanning from e-government, to military supply chain in manufacturing and financial services, to health.
- Compliance, particularly in e-government and financial services.
- Transaction mechanisms for new digital assets. Examples are cryptocurrencies, international cross-border payments, or P2P electric energy exchanges.

Distributed Ledger Technologies are still at a very early stage across all sectors, with just a few forerunner companies testing proofs of concept (POCs), while the majority are still trying to understand what this buzzword means and what it could represent for their business and daily activities. Underlying the differentiating capabilities that DLTs could bring and proving the business case, beyond POCs, will be key to translating an initial interest and appetite into real market opportunities.

It is forecast that the worldwide blockchain market will grow by a CAGR of 79.2% from 2017 to 2021 to reach €8.8 billion. The European blockchain market will grow from €182 million in 2017 to €1.6 billion in 2021 — a CAGR of 72.9%.[10]

3.2.6 Big Data and Analytics

Big data technology can be described as a new generation of technologies and architectures designed to economically extract value from very large volumes of a wide variety of data by enabling high-velocity capture, discovery and/or analysis. The Big Data and Analytics (BDA) market is comprised of hardware, software and services, which are closely tied together to derive value from the data. Increasingly, organisations are realising the value of data and are turning to BDA to enable them to compete effectively in a highly digitised world.

Most European enterprises currently using BDA are found to have a narrow focus, and small-scale and limited use cases for BDA deployments. Enterprise-wide BDA adoption is something that many organisations find challenging- However, the emergence of robotic process automation, cognitive

[10]IDC Estimates

platforms, a shift towards cloud models and reduced cost of data storage will enable organisations to deploy BDA at scale in future.

Research carried out by IDC indicates that over 60% of European organisations are at some stage of a digital transformation journey, and these organisations consider BDA a critical part of their digital strategies. The primary reason for this is that BDA is essential for real-time decision-making, based on the right information at the right time, which is key to success in the digital world. It enables organisations to become more customer-centric, to innovate quickly and to respond swiftly to changing market conditions.

The demand for data-capturing, management and analysis technologies continues to increase with the growing digitisation efforts in enterprises and the increasing number of data producers. The growth in IoT produces vast volumes of high-speed data, which needs to be captured and analysed to develop data-driven and digitally enhanced products, services and experiences. The increasing adoption of cloud, mobility and social platforms accelerates the demand for technologies to process structured and unstructured data forms as well as tools for data integration.

Traditionally, most BDA software deployments were focused on descriptive analytics to understand what has happened in the past. But now the focus is slowly starting to shift towards predictive and prescriptive analytics to answer questions on what could happen and what course of action needs to be taken. These changes in demand are forcing vendors to enhance their capabilities to incorporate prediction and optimisation as well as advanced analytics such as machine learning, deep learning, geospatial analytics and self-adapting analytics models.

BDA spending in Western Europe lags the worldwide market in overall growth, with a CAGR from 2017–2021 of 9.2% to reach €41 billion, while worldwide spending will grow at a CAGR of 12% over the same period to reach €209 billion. Research states that around 28% of Western European companies are currently using BDA, with most of the adoption coming from finance, telecom/media, professional services and transportation industries with use cases ranging from customer care to network optimisation and predictive maintenance.[11]

3.2.7 Robotics

Rapid growth in the use of robots in recent years, coupled with the publication of many of the reports referenced in this study, has led to fears that the automation of large volumes of jobs by robots is imminent. Robots are proving to be powerful business tools. They have become a solution to many tasks and applications considered dangerous, dull or costly. The growing use-cases for robots have led to their acceptance outside the traditional manufacturing factory floor.

[11] IDC Estimates

Robots are seeing growing acceptance by consumers and enterprises, especially as companies transform their business strategies and change the way they interact with customers, manufacture goods, provide services or move merchandise. Improving customer experience has become a key factor in the digital transformation strategy of many businesses, and robots and drones are helping improve efficiencies in both developed and emerging markets.

Innovators in this field are producing robots and drones that can be used in a wide range of tasks across sectors. In addition to building upon existing technology, innovators are layering on additional elements such as AI, IoT, collision avoidance systems, full automation and cloud applications. This enables robots to operate alongside people rather than replace them in the workplace. As usage increases, a rise in demand for related software and services will follow. These advances will allow organisations to adopt robots and drones into their business models more easily.

Demand will continue to grow as financial barriers are reduced and drones and robotics become more accessible. The cost-effectiveness of robotics and drones continues to warrant an increased investment in the innovative technology. Worldwide spending on robotics, drones and related hardware, software and services will grow from $103 billion in 2018 to $218 billion in 2021 at a compound annual growth rate of 25.4%.[12]

[12]IDC Estimates

Chapter 4: Understanding the Impact of the Adoption of Digital Technologies

From historical evidence, it is found that the introduction of technology into the workplace changes the workforce and their functions but does not lead to an overall reduction in the demand for workers, at least in the medium to long term. In the short term there may be some negative impact on specific areas of employment as sectors transition and individuals are reskilled, whether within the same sectors or into different sectors. New technology also brings with it the demand for new, previously undefined skills, further helping to offset the reduction in roles replaced by the introduction of technology.

As discussed in the previous chapter, the current adoption of technology across the economy is being driven by the 3rd Platform and the associated digital transformation that impacts the way in which a company operates. Automation will typically impact a business in at least one of the following ways:

- It will allow a business to undertake new activities that were not previously possible.
- It will enable the business to improve its overall productivity, not necessarily just by replacing humans with machines.
- It will enable the business to overcome resource constraints.

4.1 New Activities

For a business to thrive and survive it needs to continually evolve, adding new products and services while retiring those for which there is no longer a significant market. With the availability of new and affordable technology, businesses can create new offerings that appeal to both existing and new customers alike. The recent well-publicised challenges within the Retail sector, in some cases resulting in the total failure of well-established brands, demonstrates the risks that exist if businesses fail to adapt to changes in the market.

However, technology is not just about repurposing the existing business, it is also about enabling diversification into new areas. For an established enterprise this is where there is potential to truly create new jobs within their business and in some cases within the overall economy as well. An example of this is the highly topical area of connected vehicles. It is anticipated that this is an area where there will be significant growth opportunities for existing businesses to diversify as well as seeing the creation of new businesses in the market. New technologies will allow vehicles to communicate with the outside world in real time whilst they are on the move. The creation of a completely new infrastructure will be required for these vehicles to truly become ‘smart vehicles’ and to deliver the levels of autonomy being suggested. This varies from smart parking bays that allow the driver of the vehicle to book, pay for and navigate to an empty parking space or the car receiving information from traffic lights that advise on the optimal speed for the vehicle to travel at in order to avoid unnecessary acceleration or deceleration as well as waiting at red lights. This all requires the installation and maintenance of technology. The impact of this will see existing jobs being developed and changed as well as new jobs being created.

4.2 Productivity

Improving productivity is the key foundation of sustainable, longer term wealth creation. Being able to perform core business processes faster, with higher quality and at a lower cost, is the desire of every business. Many organisations' ability to grow to meet the potential demand in the market is inhibited by their ability to make more of the products they sell. The adoption of technology can provide the solution to this constraint by allowing greater output for a given level of inputs.

Most of the elements of the 3rd Platform will drive greater productivity. IoT, in particular, is an area that is likely to have the most significant impact across the economy. Labour-intensive activities such as monitoring equipment can be replaced with monitoring equipment that is able to report back the status of the equipment and alert the relevant teams of the need for intervention. This allows the resources to be deployed where they are needed at the time they are needed, thus driving up productivity. It also has the potential, especially where the equipment is spread over a large geographic area, for the company to increase the amount of equipment it has, thus improving its coverage and level of service to its customers.

4.3 Resource Constraints

A constant complaint from companies across the globe is that they would grow their business if only they could hire the right staff at the right cost. This is not a 21st century phenomenon, but one that goes right back to the industrial revolution in the 19th century. Automating manual processes is a well proven approach to tackling this and its continuation is anticipated.

For example, as a direct response to difficulties and expenses faces in hiring labour, farmers have adopted technology to harvest crops which were previously picked by hand. The impact for the farmer is increased levels of production, as they are no longer constrained by the lack of available labour. The labour that is available is then redeployed to manage the machines.

In developing the quantitative model for this study all elements of the economy were considered. This includes the roles most likely to see a reduction in numbers and also where new jobs are expected be created. These new jobs will encompass both an increase in existing roles and/or the creation of new roles which previously had not existed. This is evident in the area of digital marketing. Ten years ago, the role of digital marketing executive was probably completely unheard of in almost in any company. Yet with the explosion of social media, this position is commonplace, particularly amongst larger companies. Likewise, a complete digital marketing industry has evolved, creating new businesses and new jobs. In the main, these are net new jobs and businesses and not simply the replacement or rebranding of existing roles.

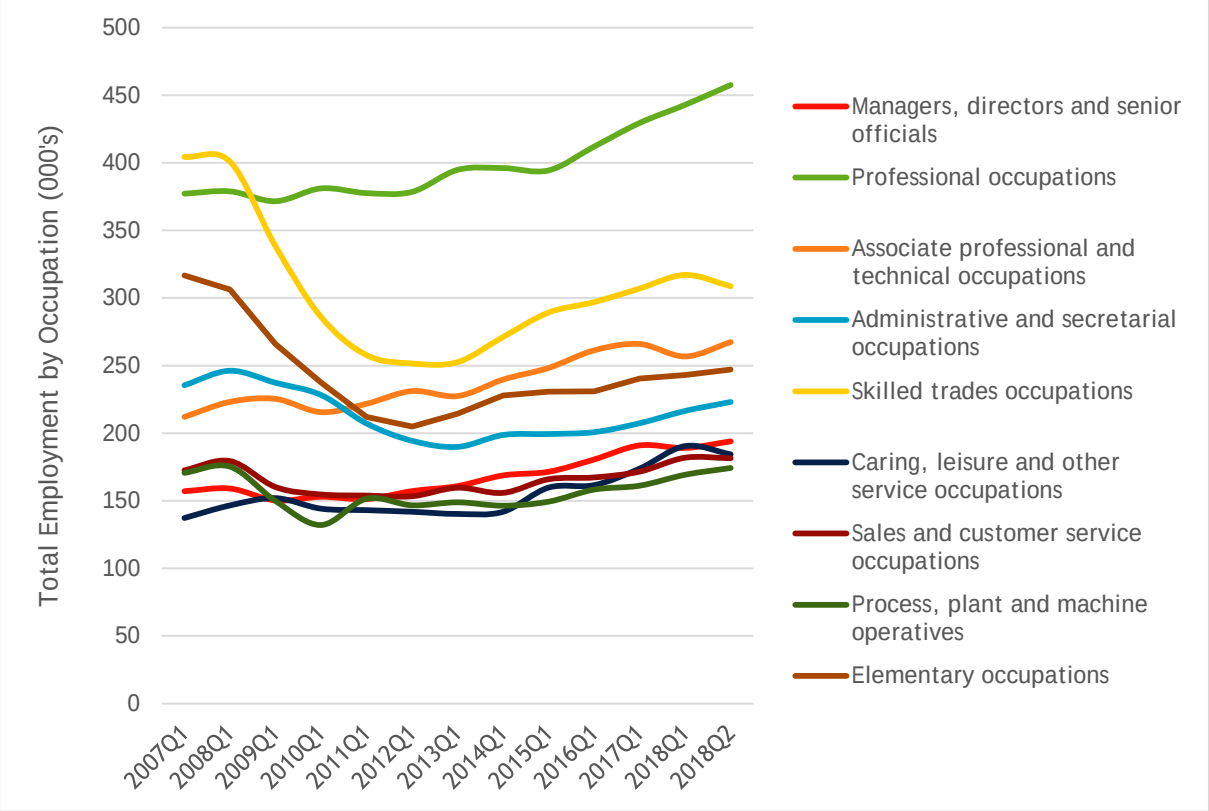
The technology that this report focuses on requires creation, installation and maintenance, and that in itself is a creator of jobs. While it is a fact that the manufacturing of technology is often done in Asia, the installation and maintenance of the technology will often require resources in the locations where it is used, providing job opportunities. It is clear that in the 21st century the ability for an individual to set up and successfully run a business, either on their own or employing staff,

has never been easier. Technology has a significant role to play in enabling this to happen. It is these new small businesses that have the potential to grow and develop to become employers in the future.

Chapter 5: Sectoral Perspective on the Impact of Adopting Digital Technologies

The long-term trend for employment in Ireland has seen a significant recovery since the global crash of 2007. At the end of Q1 2007, there were 2.18 million people in employment, which declined to 1.86 million in Q1 2012. Ireland's recovery is now well-embedded, having seen consistent growth since 2013 and employment growing to 2.25 million in Q2 2018. Growth in employment has occurred across all occupations, though some saw stronger demand than others (Figure 3).

Figure 3: Annual Number of Employees by Occupation (SOC2010) Q1 2007–Q2 2018

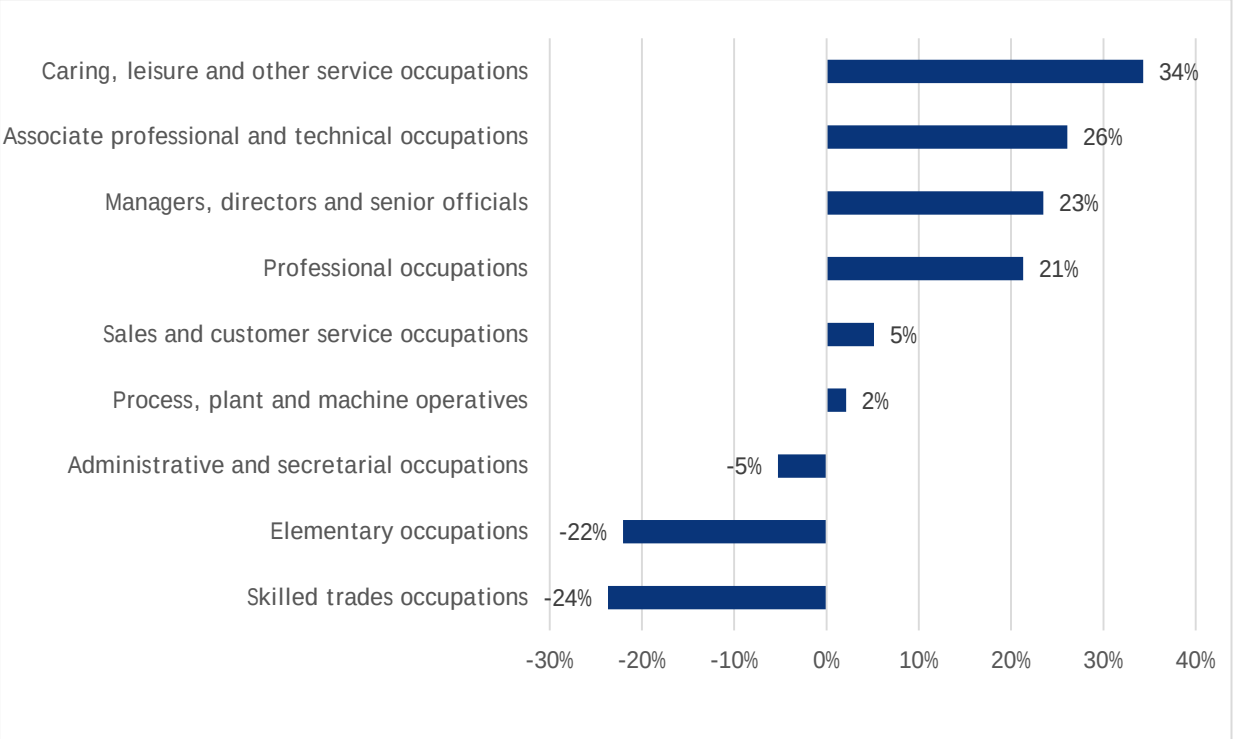


Source: CSO, Persons aged 15 years and over in Employment (Thousand) by Sex. [13]

The strong economic growth Ireland has experienced over the past six years is down to several factors: a reversal in migration as the economic recovery attracted workers from abroad; net increases in participation for individual age groups of working age; increased positive economic outlook that is seeing business invest in growth areas; and new jobs in areas such as IT and Hospitality. This is benefiting a range of occupations, including caring, leisure and other service occupations; associate professional and technical occupations; managers, directors and senior officials; and professional occupations (Figure 4). In comparison, those occupations that feature repetitive, mundane and highly manual tasks have fared less well, with elementary and skilled trades suffering in particular.

[13]Excludes "Other/not stated" of which there were 16,900 in Q2 2018

Figure 4: Change in Employment Levels by Occupation (SOC2010) Q1 2007–Q2 2018



Source: CSO, Persons aged 15 years and over in Employment (Thousand) by Sex

However, this might be a misleading picture. Comparing the change in employment from Q1 2012, the bottom of the decline in employment, to Q2 2018 figures, all occupations have demonstrated strong growth. In fact, skilled trades employment levels grew by 23% over this period, reflecting the recovery in sectors that had been hit hardest by the recession, such as housebuilding.

Whilst a number of sectors are showing signs of recovery, all the jobs that were lost in every sector have yet to be replaced. The difference between the number of people employed in skilled trades in Q2 2018 is 95,700 less than in Q1 2007, even after six years of consistent growth. The number of elementary workers has reduced by 69,800 and there are 12,400 less administrative and secretarial positions. Therefore, while the overall recovery in employment is well-established, it is likely that the structure of the workforce across Ireland has changed for the long term.

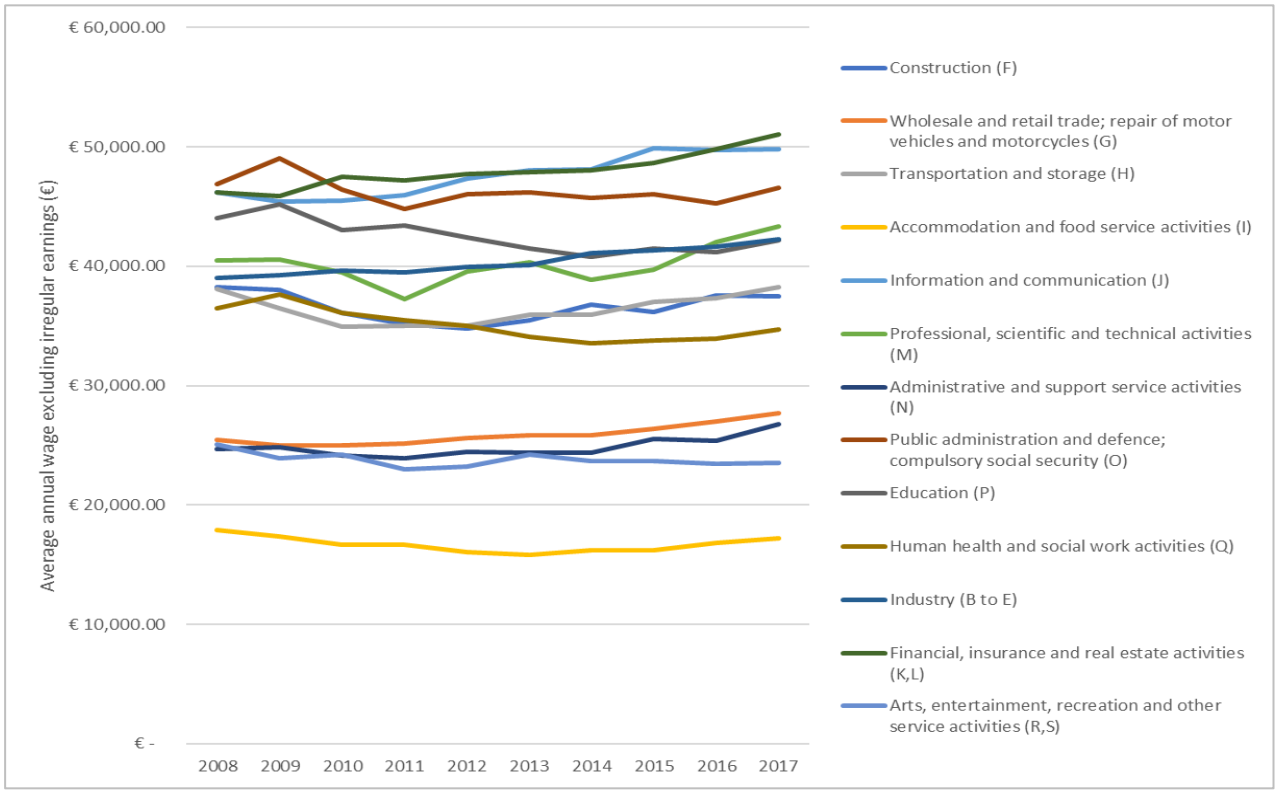
5.1 Wages Reflect Demand for Workers Across Sectors

The drivers of wage growth are many and complex in their interactions, but they are also an indicator of the relative demand for labour across sectors. In 2017, the average wage (excluding irregular earnings) across all sectors was €35,635, a 2% increase over the 2008 average of €34,826. Mirroring the changes in demand for labour by occupation, wage growth across sectors has also varied considerably. Those sectors associated with manual, unskilled and repetitive tasks have suffered. The average wage for employees across Accommodation and Food Service Activities has

declined by 4%, from €17,880 in 2008 to €17,179 in 2017. Employees in the Construction sector have seen wages fall by 2%, from €38,234 in 2008 to €37,513 in 2017.

Over the ten-year period, the strongest growing sector in terms of wages has been Financial, Insurance and Real Estate activities. It has grown from €46,181 in 2008 to €51,043 in 2017. Wage growth in Wholesale and Retail trade was also strong, growing from €25,445 in 2008 to €27,696 in 2017. Although, it should be noted the starting point was the third lowest of all economic sectors, only beating Administrative and Support Service Activities and Accommodation and Food Service Activities.

Figure 5: Change in Average Earnings (Excluding Irregular Earnings) 2008 - 2017



Source: CSO, Average Total Earnings excluding Irregular (Euro) by Type of Employment, NACE Rev 2 Economic Sector and Year

Looking at the wage changes since 2012, the sectors most aligned with the growth in occupations have seen the biggest increase in wage growth. For example, the Construction sector is heavily aligned with skilled trades and elementary occupations. Though still below Q1 2007 levels, both wages and number of employees in these areas have grown since 2012. Similarly, wage growth and employees in those areas with high cognitive tasks have seen robust growth since 2012. The number of employees classified as associate professional and technical occupations has grown by 21% since 2012, while wage growth in economic sectors associated with professional, scientific and technical activities has grown by 10% over the same period.

5.2 Theory of Impact from Adoption of Automation

There have been several headlines over the past five years about the potential impact of automation and robotics on the number of jobs worldwide. The first of its kind was the highly influential study by Frey and Osborne (F&O). Their research, published in 2013, was the first attempt to size the impact of automation on workforces.

The authors built on past research that looked at the ability of computers to do "routine" tasks by authors such as Autor *et al*.[14] F&O argue that computers can now do tasks that wouldn't have been considered "routine" a few decades ago. However, adoption was being held back by what they described as engineering bottlenecks for computers (i.e. tasks that given the current state of knowledge were difficult to automate) such as perception and manipulation tasks, creative intelligence tasks and social intelligence tasks.

The base data for their research comes from the USA database O*NET. O*NET describes 903 occupations across industries in the USA alongside descriptions of the skills people need to have in each occupation. F&O took a sample of 72 occupations and subjectively hand-labelled the occupations with a code of 1 if fully automatable or 0 if not. The label was based on the researcher reviewing the tasks and job description and considering if the task could be performed by computer-controlled equipment if the computer had enough data on the task.

The second step in their process aimed to overcome the subjective nature of the first step by ranking the capabilities of employees into nine broad areas which were tied back to the three engineering bottlenecks they had identified. By applying statistical modelling to these they calculated the probability of these capabilities being replaced by a computer and therefore the probability of the overall job being replaced. By running this model across the entire O*NET database they came up with a figure of 47% of the 903 occupations could be classified as being at high risk due to automation. F&O distinguish between high, medium and low risk occupations, depending on their probability of the task being replaced by a computer, the threshold being 0.7 for high risk and 0.3 for low risk. Everything else in between is considered at medium risk.

This approach has limitations when considering the real world. Firstly, the research focuses only on the task being performed and the level of dexterity and cognitive effort required. In doing so, the research does not reflect the way enterprises and employees adopt technology in real life. Enterprises do not view employees in terms of the distinct tasks they perform. For example, the study does not consider the organisational knowledge that is contained within the workforce and that could be lost through the removal of humans. Therefore, it is unlikely that enterprises will view the introduction of automation in this way.

It is also important to consider the interpretation of what can be considered ‘low level’; similar tasks undertaken in different industries can have different levels of importance attached to them,

[14] Autor, David H. and Dorn, David, ‘The Growth of Low Skill Service Jobs and the Polarization of the US Labour Market’, American Economic Review, 2013.

running the risk of overstating the risk to low-wage, low-skilled, manual jobs across industries. Furthermore, F&O's suggestion that 47% of jobs in the United States were at high risk of being automated was called into question when considering the real world. It was considered a limitation of the F&O approach that it focused on how automation would eliminate routine intensive occupations. Subsequent publications, building on the F&O approach, looked at how automation would affect the tasks in occupations instead of occupations in their entirety. Accounting for the automation of tasks within roles was deemed to be a better measure when estimating job loss figures.

Uncertainty also arises when considering the way in which employees will react. Some might decide to find alternative work before their role disappears with automation. This leaves the employer with a difficult decision. They can choose to either fill the role and then remove it, reallocate duties across remaining staff, or leave the position vacant and instead begin investment into automation. Some employees might opt to remain in their roles, others might simply decide to retire. This uncertainty presents serious challenges to policy-makers who are considering long-term planning for social support and education across the workforce now and in the future. A further weakness of the studies to date is that they do not consider the impact on business processes and how automation will change these, enabling new business models to arise and potentially giving access to new markets.

Since the publication of F&O's paper, other researchers have tried to refine the approach to address these issues. In 2015, McKinsey & Company published "Four Fundamentals of Workplace Automation", which analysed automation from a task perspective rather than an occupation perspective. They found that 45% of work activities that were undertaken by employees in the USA could be automated today. However, they found that fewer than 5% of occupations could be entirely automated. This was followed in 2016 with a study by Arntz *et al.* for the Organisation of Economic Co-operation and Development (OECD).[15] The authors believed that F&O might be overestimating the ease of automation and the technical possibility to use machines rather than humans for the undertaking of "tasks". They believed that while an occupation might be considered high-risk, the ability to automate all tasks was hard to overcome. The use of this data allowed for recent studies to account for the number of tasks that would be eliminated within occupations as opposed to whole occupations. This resulted in the estimates of jobs at risk of automation to reduce significantly in comparison to the F&O study.

Rather than use O*NET, which meant only considering the USA, the authors expanded their research to include a broader set of countries. To do this they used data from the Programme for the International Assessment of Adult Competencies (PIAAC) dataset. This dataset covers 40 countries, with 5,000 interviews in each. Not all countries were surveyed at the same time; round one was conducted between 2008 and 2013, round two was conducted between 2012 and 2016, while round three covers 2016 to 2019. There were 23 countries in the first round, 9 in the second and 6 in the

[15]Arntz, M., T. Gregory and U. Zierahn (2016), "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis", *OECD Social, Employment and Migration Working Papers*, No. 189, OECD Publishing, Paris, available from: https://doi.org/10.1787/5jlz9h56dvq7-en.

third. PIAAC contains information on tasks, including the need for exchanging information, training others, presenting, selling, negotiating, consulting and reading. This allowed them to understand the level of group work or face-to-face interactions. These are tasks which cannot be replaced by machines yet, or are likely to be in the next couple of decades. Matching this data to F&O allowed for a direct comparison. The authors found that only 9% of OECD jobs are automatable compared to the 47% of jobs found by F&O. Roles which had previously been ranked as high risk were now ranked as low or medium risk due to the amount of group work or face-to-face interactions undertaken as part of that occupation.

This work has subsequently been built on by the likes of Nedelkoska and Quintini (N&Q) in 2018, who expanded upon the task-based approach developed by Arntz et al using PIAAC data.[16] This approach took into consideration a far broader range of occupations, including those that do not yet involve technology. They also identified the same automation bottlenecks that F&O identified, aligning their approach more with the impact derived from automation technologies based around machine learning. The research found that 14% of jobs in OECD countries had a probability of automation of over 70%. This is equivalent to approximately 66 million workers across the 32 countries covered by the data.

However, the figure of 14% is slightly misleading as they found large variation across countries, 33% of occupations across Slovakia have a high probability of automation compared to 6% in Norway. They also found that a significant number of jobs were at medium risk (50 to 70% probability) of being replaced by automation. Again, this varied significantly across countries. The report highlights the gap between those countries which have already undergone structural change due to the adoption of technologies and the move away from industrial sectors to service-orientated sectors. Occupations within these sectors are by their nature harder to automate with the current level of technology.

Reviewing the past approaches, it is clear that each study had to grapple with significant levels of uncertainty about the way in which technology will be adopted and how this will impact the tasks that make up occupations. While many of these studies base their predictions on the original study undertaken by F&O, the range of predictions of jobs at risk of being removed varies significantly. Globally, it ranges from a few million to hundreds of millions depending on time-frames, sectors covered, and technology involved. Considering the impact solely at a global level generates considerable variation, as illustrated in Table 1. Given the spread of estimates, it is clear that a consensus on the impact of automation on jobs has yet to be reached.

[16] Nedelkoska, L. and G. Quintini (2018), "Automation, skills use and training", *OECD Social, Employment and Migration Working Papers*, No. 202, OECD Publishing, Paris, available from: https://doi.org/10.1787/2e2f4eea-en.

Table 1: Predictions for Jobs Worldwide at Risk of Being Lost and Created by Automation

When	Where	Jobs Lost	Jobs Created	Predictor
2016	Worldwide		900,000 to 1.5m	Metra Martech
2020	Worldwide		1m to 2m	Metra Martech
2020	Worldwide	1.8m	2.3m	Gartner
2020	Sample of 15 countries	7.1m	2m	World Economic Forum
2021	Worldwide		1.9m to 3.5m	International Federation of Robotics
2030	Worldwide	2bn		Thomas Frey
2030	Worldwide	4m to 8m	5.5m to 8.9m	PwC

Source: MIT Technology Review [17]

5.3 Probability of Automation in Sectors

The occupational groups with high probability of being impacted by automation over the next five years were identified by applying a breakdown of the F&O data against data from the Central Statistics Office (CSO) for the population aged 15 years and over in the labour force in 2011 to 2016. 186 occupations were matched against the 330 detailed to assess the composition of Ireland's labour force based on the future risk of automation. The total number of people actively engaged in work at the end of 2016 across Ireland was 2 million. 1.4 million of these were matched against the top-level occupations by taking the mean probability for occupational groups at a detailed level for the F&O data and the most recent report, the OECD N&Q report. These were applied to the last complete set of employment figures at the same occupational grouping level that are available from CSO (Table 2).

[17] Please note that these numbers are based on MIT Technology Review estimates of percentages listed in reports. Winick, Erin 'Every study we could find on what automation will do to jobs, in one chart'. MIT Technology Review, 25th January 2018. Available from: https://www.technologyreview.com/s/610005/every-study-we-could-find-on-what-automation-will-do-to-jobs-in-one-chart/

Table 2: Workforce Probability of Impact from Automation (000s)

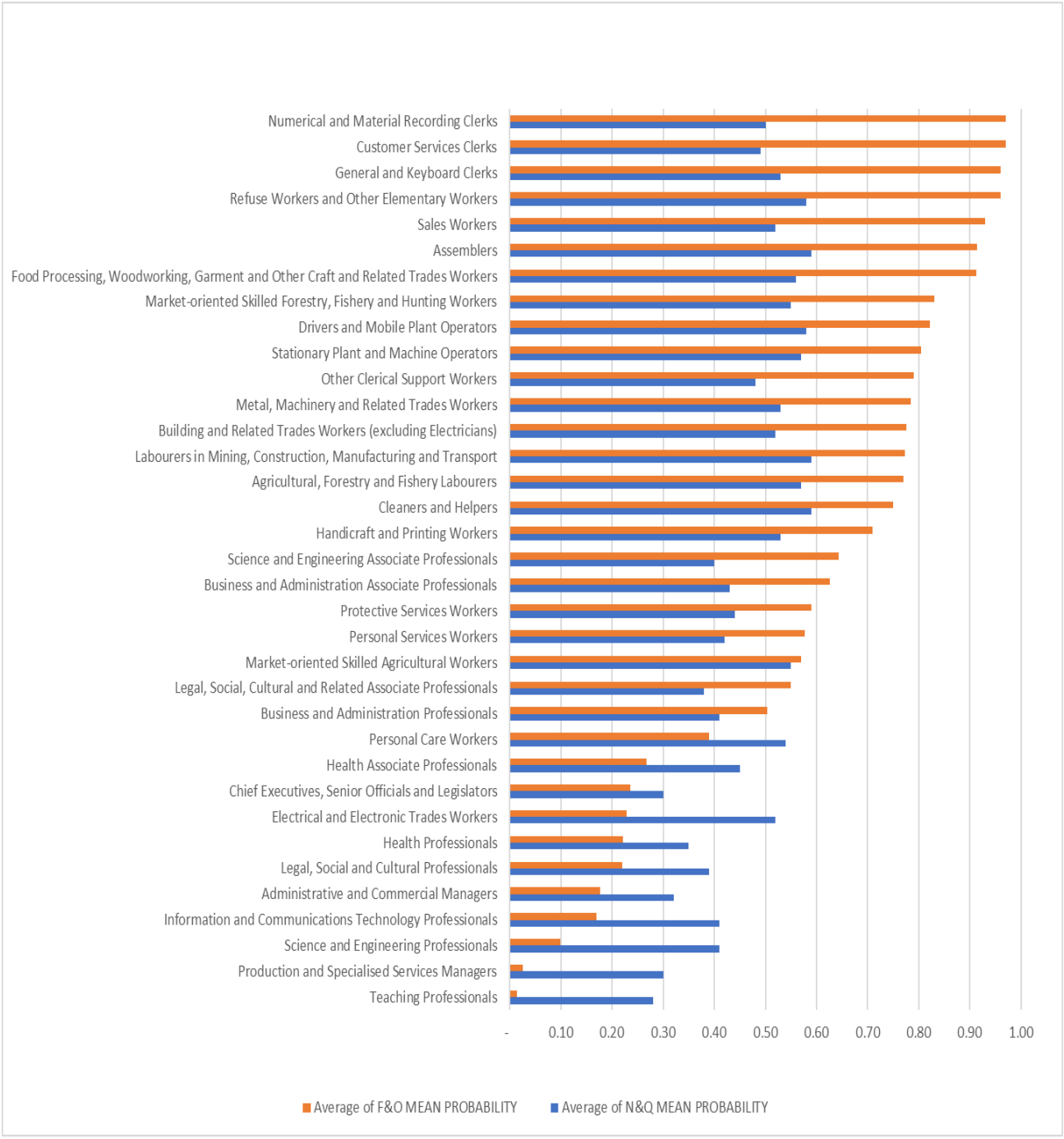
Occupation Group	Workforce 2016	N&Q Mean Probability	F&O Mean Probability
Professional occupations	257,709	0.40	0.15
Skilled trades occupations	242,793	0.52	0.68
Managers, directors and senior officials	128,896	0.31	0.18
Associate professional and technical occupations	189,739	0.43	0.47
Elementary occupations	180,378	0.49	0.56
Caring, leisure and other service occupations	191,490	0.41	0.58
Process, plant and machine operatives	101,687	0.52	0.82
Administrative and secretarial occupations	39,588	0.44	0.75
Sales and customer service occupations	154,995	0.50	0.81
Total	1,487,275	0.45	0.51

Source: IDC estimates based on F&O, N&Q, and CSO data for 2016

Jobs at risk of automation vary significantly using the two different approaches (Figure 6). Previous studies indicated that the higher the percentage of manual, repetitive tasks a job consists of, the higher probability that the role will be automated. Accordingly, those occupations with a low level of risk of being automated tend to consist of a higher number of tasks that require social, cognitive and literacy skills. The one sector that bucks this trend is human health and social work activities. While many of the occupations within this sector are made up of manual tasks, they include a large amount of social and literacy skills, which to some extent insulates them from automation.

The top five occupations at high risk using F&O data are customer service clerks (97% probability), numerical and material recording clerks (97%), refuse workers and other elementary workers (96%), general and keyboard clerks (96%) and sales workers (93%). These differ in the top industries when using N&Q data, where the top five occupations at risk are assemblers (59% probability), cleaners and helpers (59%), labourers in Mining, Construction, Manufacturing and Transport (59%), refuse workers and other elementary workers (58%) and driver and mobile plant operators (58%).

Figure 6: Mean Probability of Impact of Automation by Occupation Group, Comparing F&O and N&Q



Source: IDC estimates

Chapter 6: Quantitative Model Assessing the Impact of Digital Technologies in Ireland

While each of the studies discussed in the previous chapter focussed on tasks and the potential for individual tasks to be automated, they have ignored the appetite and ability of firms to invest in digital technologies. In this report, rather than take the potential for automation of a task as the single operator, the ICT spend on 3rd platform technologies and the rate of change of spend have been used as a proxy for digital adoption. This has been combined with the mean of the results found in previous studies' probability of an occupation being automated to generate overall estimates. In the model it has been assumed that there will be no major shocks to the economy over the forecast period from Brexit, deterioration in world trade from increasing trade wars or developments of digital taxation. Full details on the methodology can be found in Appendix 3.

6.1 Calculating Total Employment Before and After Digitalisation

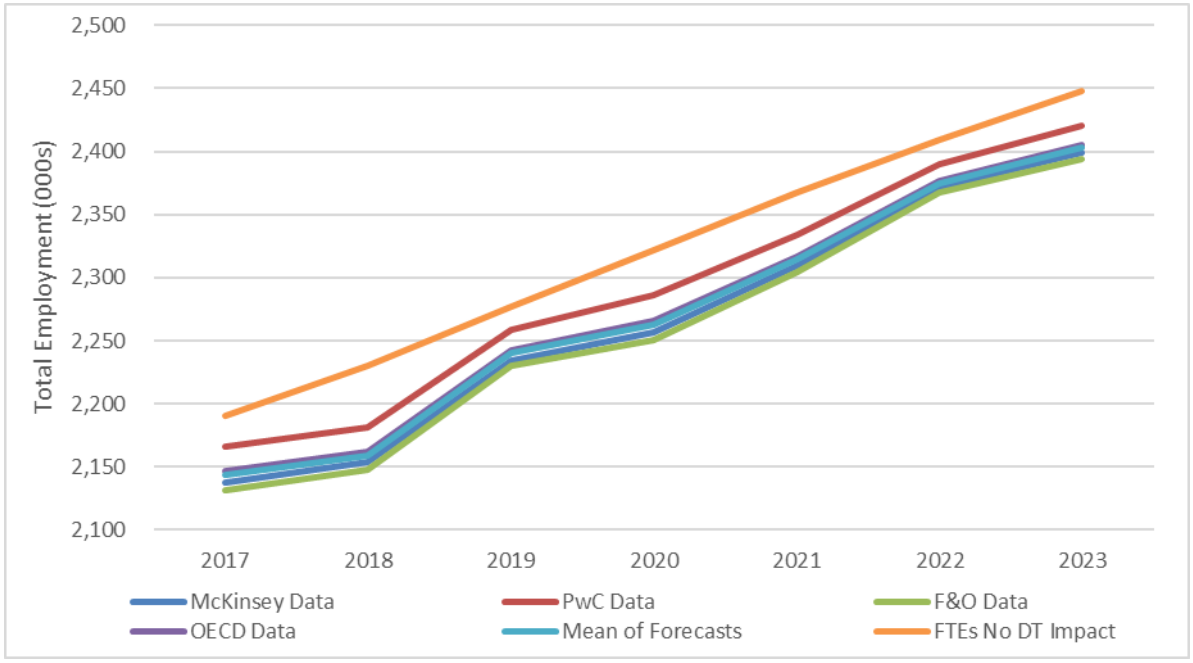
To calculate total employment before digitalisation, the required employment to produce GNI* projections was estimated to 2023. This was estimated by calculating the number of hours of labour required to produce the Department of Finance GNI* projections, whilst taking account of changes in output per hour worked in each sector of the economy, based on recent trends. As it happens, these cumulative projections are almost identical to current Department of Finance projections for total employment for 2023. Projections were then made for employment by sector broken down by occupation, level of educational attainment and region, based on recent trends in CSO data.

To calculate the total employment after digitalisation four major studies were drawn upon:

- 'The Future of Employment: How Susceptible are Jobs to Computerisation?' Frey and Osbourne, 2013
- 'The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis' OECD, 2016
- 'Will Robots Really Steal Our Jobs? An International Analysis of the Potential Long-Term Impact of Automation' PwC, 2018
- 'Workforce Transitions in a Time of Automation' McKinsey Global Institute, 2017

Figure 7 demonstrates the impact on total employment using the different methodologies. The overall impact of digitalisation in these studies ranges from a loss of 25,000 jobs to 55,000 jobs by 2023. Thus, using the mean of these estimates was deemed the most appropriate method of estimating the impact on the workforce in Ireland.

Figure 7: Total Employment Using Different Methodologies



Source: IDC, 2018

In combining the outputs from the different models, a detailed picture was developed of the possible risk to individual occupations. The F&O data is taken as a starting point, which through a crosswalk process has been matched to data for Ireland. Where an occupation could not be matched directly to a comparable occupation it has been excluded. Where possible data has also been matched from the other studies considered. The final figure for occupations has then been grouped into nine occupational groups as set out in Table 2 in Section 5.3, those being: professional occupations; skilled trades; managers, directors and senior officials; associate professional and technical occupations; elementary occupations; caring, leisure and other service occupations; process, plant and machine operatives; administrative and secretarial occupations; and sales and customer services occupations. The occupations were then classified according to probability of automation as one of the following:

- **High risk**, a probability score of 70% or over
- **Medium risk**, a probability score of greater than 30% but less than 70%
- **Low risk**, a probability score of less than 30%

Applying the output to occupations allows for estimation of the potential for the role to be replaced. Technical feasibility is not the sole driver for adoption, nor is adoption linear, it is dependent on many aspects. Previous research has characterised this as adoption waves. F&O characterised this as two waves. The first related to manual tasks and the second, later stage, related to addressing the engineering bottleneck they viewed as associated with complex tasks that

require higher cognitive functions. Price Waterhouse Cooper (PwC) identified three overlapping waves, algorithmic (now to 2020's), augmentation wave (to late 2020's) and autonomous wave (to mid-2030's).

To factor in assumptions about adoption this report uses IDC's data on ICT expenditure estimates and projections for both legacy technologies (technologies which can be classified as mainframe and client/server/internet technology) and 3rd platform technologies across the different industries, over the period 2016-2022. The data used is the combination of qualitative and quantitative data from several primary and secondary sources, including IDC Trackers and Spending Guides. Staff spend has been excluded from these numbers and only the spend on hardware, software and services has been taken.

To estimate the impact of the spend, this report has taken the growth rates for the different technologies and compared them to the legacy adoption rates. This results in the measurement of the impact from the adoption of 3rd platform technologies. The growth rates for the different technologies are applied to the probability of impact from automation for each occupation and sector. This represents the proportion of the total probability that can be applied to total employment in each occupation in each sector in each year, that could be removed due to the spend on 3rd platform technology in that year. With these factors considered, the impact of digitalisation on occupations was calculated for the forecast period. Total employment after digitalisation by occupation was then subtracted from total employment before digitalisation by occupation to attain the impact of digitalisation.

It should be noted that the creation of new jobs arising from the adoption of digital technologies is not included separately in the model. The model projects the size of future employment by estimating the amount of labour required to produce future GNI* projections. This projection takes account of changes in productivity based on past trends. Therefore, the forecast for the projected labour requirement, with no impact from digital technologies, contains some growth in jobs which is attributable to the past investments made in technology. This is dependent on the assumption that GNI* growth is partially being driven by sectors investing into technology to improve sales and operating margins, the development of extensions to existing services and products, as well as new ones which are derived from investment into technology. Furthermore, the extent of automation, and therefore the probability of risk to occupations, may be less or more depending on how governments and private sector organisations react to the economic, legal, regulatory and organisational challenges.

6.2 Sensitivity Analysis

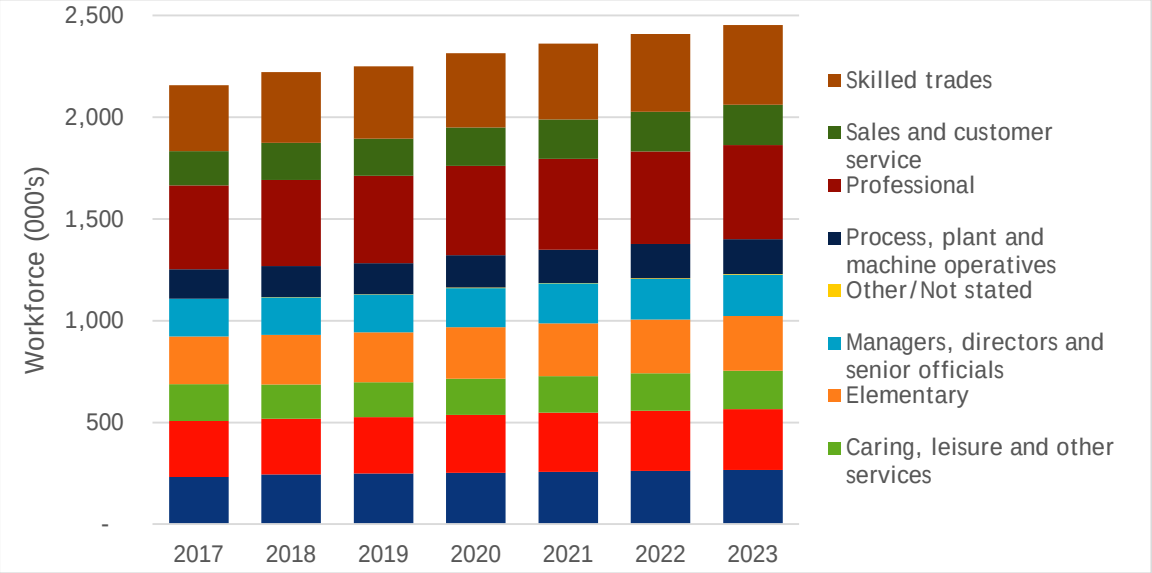
A sensitivity analysis was conducted to understand how the model would respond to changes in the forecast GNI* projections, as developed by the Department of Finance. In order to assess the model in different growth scenarios the GNI* projections were both increased and decreased by 10 percent for each of the years 2018-2021. When GNI* projections were increased by 10 percent this resulted in an estimated total of 33,000 hypothetical job losses – representing a decrease of 13,000 from the model's projected net hypothetical job losses of 46,000. When GNI* projections were decreased by

10 percent this resulted in an increase in the net hypothetical job losses figure, a deviation of 1,300.

6.3 Projections

Excluding the impact of digitalisation, the model predicts growth in the underlying size of the Irish workforce, rising from 2.2 million in 2017 to reach 2.49 million in 2023, a CAGR of 2% (Figure 8). This is in line with the Department of Finance projections published in Budget 2019.

Figure 8: Workforce Growth With No Impact from Adoption of Digital Technologies



Source: IDC estimates 2018

It is projected that the disruption from the adoption of digital technologies is unlikely to lead to a sudden, overnight fall in the demand for labour. Rather, it will be a gradual process as enterprises move from a relatively low maturity in their adoption and application of digital technologies to a mature, enterprise-wide approach. Given this, it is estimated that the impact on jobs will be relatively light between 2018 and 2023, with 46,00 jobs being lost to automation across all occupations by 2023 (Table 3). This is 1.8% of the forecast number of the 2.49 million employees by 2023.

Table 3: Forecast Change in Workforce Numbers Due to Adoption Digital Technologies (000s)

Total Economy	2017	2018	2019	2020	2021	2022	2023
Total Irish Workforce **Before** Accounting for Impact of Digital Technologies	2,222	2,250	2,314	2,362	2,409	2,453	2,494
Year-on-Year Change	2.9%	1.3%	2.8%	2.0%	2.0%	1.8%	1.7%
Total Irish Workforce **After** Accounting for Impact of Digital Technologies	2,173	2,179	2,239	2,262	2,314	2,418	2,448
Year-on-Year Change	0.7%	0.2%	2.8%	1.0%	2.3%	4.5%	1.3%
Difference (000s)	-	-	-	-	-	-	-

	48	72	75	100	95	35	46
Difference (%)	-2.2%	-3.2%	-3.3%	-4.2%	-4.0%	-1.4%	-1.8%

Source: IDC estimates 2018

Table 4 demonstrates the growth of the workforce over the period of 2018-2023 when the impact from the adoption of digital technologies is included. The total workforce is expected to grow from 2.17 million in 2018 to 2.45 million in 2023. The data indicates that the demand for each of the occupational groups will increase over the next five years with each occupational group forecast to experience small annual growth year-on-year.

Between 2018 and 2023, the occupations showing the largest overall growth is forecast to be skilled trades (+50,100) and professional occupations (+40,100). The smallest growth will be seen in caring, leisure and other services (+21,200) and managers, directors and senior officials (+20,700), although both occupational groups are estimated to experience consistent growth year-on-year.

Table 4: Workforce Growth Including the Impact Adoption of Digital Technologies — Occupation Group (000s)

Total Employment After Impact from Digital Technology	2018	2019	2020	2021	2022	2023
Total Workforce	2,178.5	2,277.0	2,301.2	2,354.7	2,417.8	2,448.3
Year-on-year change	0.24%	4.52%	1.06%	2.33%	2.68%	1.26%
Administrative and secretarial	239.3	249.6	251.1	255.7	262.3	264.8
	0.04%	4.30%	0.61%	1.84%	2.55%	0.97%
Associate professional and technical	267.5	280.3	282.3	288.0	295.4	298.3
	-0.18%	4.77%	0.74%	2.01%	2.56%	0.97%
Caring, leisure and other services	167.9	175.3	177.9	182.0	186.2	189.1
	0.96%	4.38%	1.47%	2.32%	2.33%	1.57%
Elementary	234.6	247.1	249.2	256.0	263.9	267.0
	-0.15%	5.32%	0.84%	2.71%	3.09%	1.18%
Managers, directors and senior officials	184.8	191.3	194.6	198.6	202.6	205.5
	0.77%	3.52%	1.76%	2.04%	1.99%	1.47%
Process, plant and machine operatives	143.2	154.9	156.0	161.1	167.6	169.9
	-1.81%	8.17%	0.71%	3.27%	4.01%	1.38%
Professional	427.6	437.9	445.1	453.2	461.2	467.7
	1.24%	2.40%	1.65%	1.81%	1.76%	1.42%
Sales and customer service	174.4	183.8	185.0	189.2	194.6	196.3
	-0.90%	5.44%	0.62%	2.28%	2.87%	0.85%
Skilled trades	337.3	354.7	357.7	368.7	381.9	387.4
	0.53%	5.16%	0.86%	3.08%	3.56%	1.45%

Source: IDC estimates 2018

Table 5 examines the impact of digital technology across sectors. Over the forecast period, Agriculture, Retail, Transport, Hospitality and Manufacturing are estimated to see the largest percentage of their workforce lost to the adoption of digital technologies (Table 5). It is not surprising to see these sectors among the top sectors as they contain higher proportions of occupations already identified as having a higher probability of risk of disruption from the adoption of digital technologies.

Table 5: Workforce Growth Including the Impact Adoption of Digital Technologies — Industry Group (000s)

NACE Economic Sectors	2018	2019	2020	2021	2022	2023
Total Workforce	2,178.5	2,277.0	2,301.2	2,354.7	2,417.8	2,448.3
Year-on-year change	0.24%	4.52%	1.06%	2.33%	2.68%	1.26%
Agriculture	102.4	104.4	102.2	103.7	105.3	104.6
	-0.38%	1.90%	-2.05%	1.44%	1.58%	-0.69%
Utilities and Mining / Quarrying	29.1	31.7	31.9	32.6	33.5	33.8
	-4.09%	8.96%	0.51%	2.29%	2.80%	0.90%
Manufacturing	233.1	257.9	259.0	267.0	276.9	280.7
	-4.17%	10.61%	0.44%	3.07%	3.70%	1.38%
Construction	140.0	145.3	152.7	161.9	171.8	179.3
	7.79%	3.84%	5.08%	6.04%	6.10%	4.40%
Retail, Transport, Hospitality	545.3	576.9	580.8	594.9	613.1	618.8
	-1.04%	5.79%	0.68%	2.43%	3.05%	0.94%
IT	146.7	151.9	153.9	156.3	158.9	160.1
	0.12%	3.56%	1.34%	1.54%	1.65%	0.75%
Financial Services	93.7	91.8	91.2	91.1	91.7	90.9
	2.89%	-2.07%	-0.61%	-0.12%	0.68%	-0.90%
Real Estate	10.7	10.2	10.2	10.2	10.2	10.1
	4.48%	-4.38%	-0.22%	-0.26%	0.00%	-0.89%
Professional, Administration Support	213.6	216.8	218.5	220.7	223.5	224.9
	1.17%	1.48%	0.77%	1.00%	1.28%	0.63%
Public Admin, Education, Healthcare	552.7	568.0	577.2	588.6	601.8	612.2
	1.14%	2.78%	1.62%	1.97%	2.25%	1.72%
Arts, Entertainment, and Other	111.2	122.1	123.5	127.8	131.1	132.9
	0.53%	9.77%	1.18%	3.47%	2.58%	1.35%

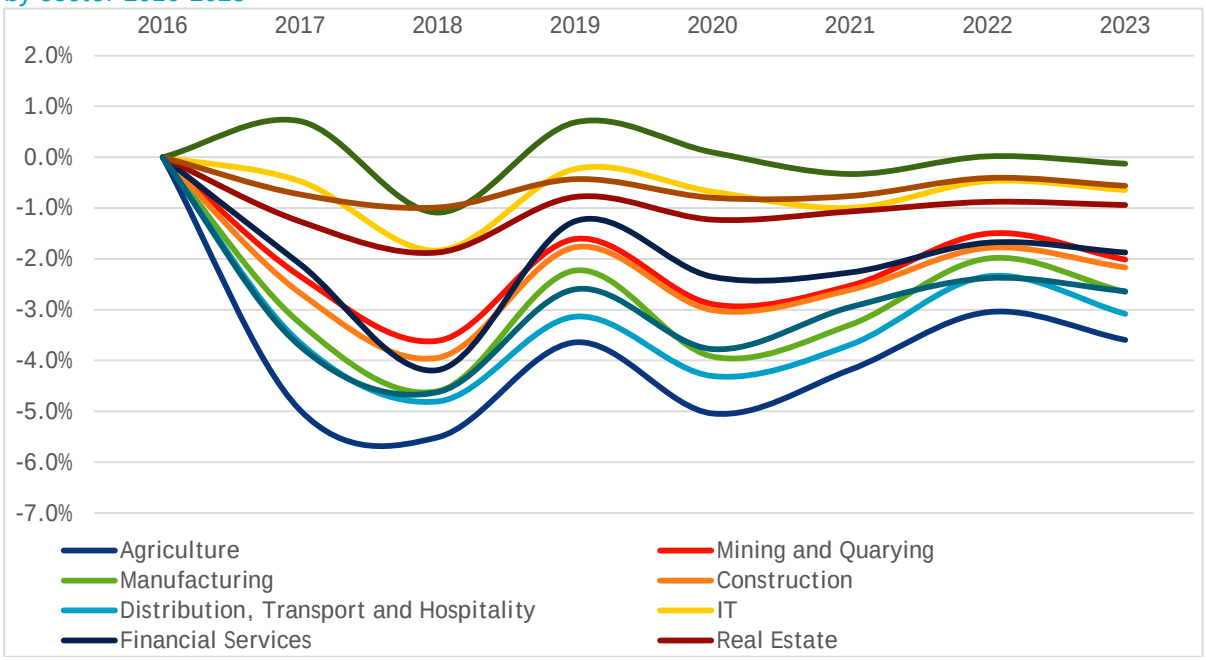
Source: IDC estimates 2018

6.4 Displacement of Jobs from the Adoption of Digital Technologies

Between 2018 and 2023, national employment is expected to continue to grow as Ireland continues its recovery from the financial crash. While there are many external uncertainties that might impact Ireland's ongoing economic growth (Brexit, global trade wars, currency fluctuations etc.), this report focuses on the impact from investment into digital technologies. While a considerable number of occupations are at high risk of automation, by 2023 it is forecast that approximately 46,000 roles will have been displaced due to the adoption of digital technologies. Performance by sector is likely to vary, with some sectors performing better than others, due in part to the tasks performed within those sectors. The forecasted trajectory of the workforce in each of the sectors is displayed in Figure 9, which shows the year-on-year impact. While jobs are being displaced by technology, the overall size of the workforce continues to grow. The rate of expansion of the economy and the workforce is greater than the rate of contraction of tasks and occupations from technology, meaning that overall the workforce will continue to grow. Technology adoption is having only a limited damping effect currently.

Many occupations contain tasks that have a high susceptibility to automation, but that does not mean that that job will be easily replaced by technology. It is also not expected that the rate of disruption will be linear. Investment in technology tends to be spread over many years. The impact on processes and therefore tasks and jobs can take longer to filter through in terms of the removal of jobs. Enterprises' adoption of technology tends to be driven by point solutions which address a specific business need. Adopting technology and changing business processes and practices often requires specialist skills sets. The recruitment of staff with specialist skills can often offset the initial reduction in workforce numbers.

Figure 9: Percentage of the Workforce in Ireland Displaced by the Adoption of Digital Technologies by Sector 2016–2023

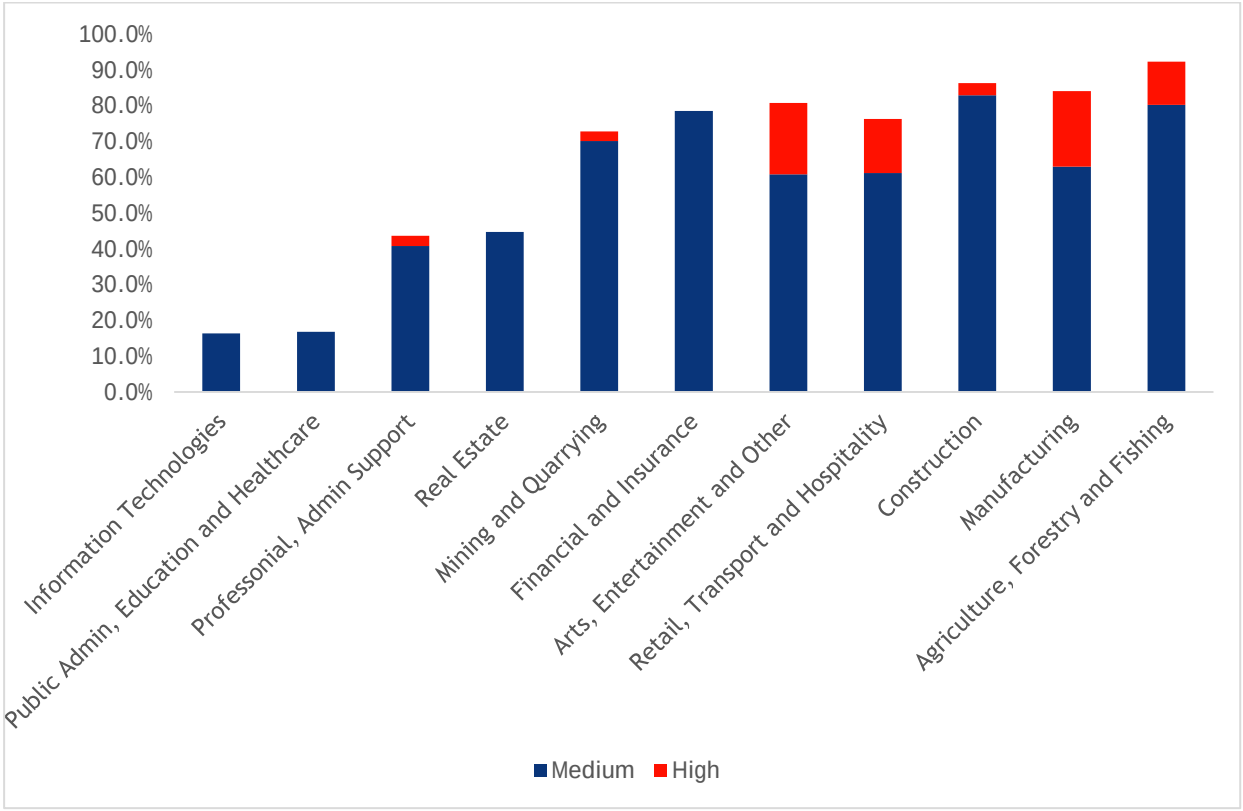


Source: IDC estimates 2018

6.5 Sectoral Projections

Figure 10 shows the distribution of risk across sectors for the mean of the models considered. While the sector with the highest proportion of jobs that would be considered at high risk of automation is the Retail, Transport and Hospitality sector at 22.5%, the picture changes when adding in workers at medium risk. Agriculture, Forestry and Fishing was identified as the sector with the highest proportion of workers at risk at 98%, followed by Manufacturing sector at 89% and the Construction sector at 86%. The sectors with the lowest risk remained Information Technologies at 16% and Public Administration, Education and Healthcare at 17%.

Figure 10: Sectors by Risk from Automation



Source: IDC estimates

6.6 Sector Viewpoints

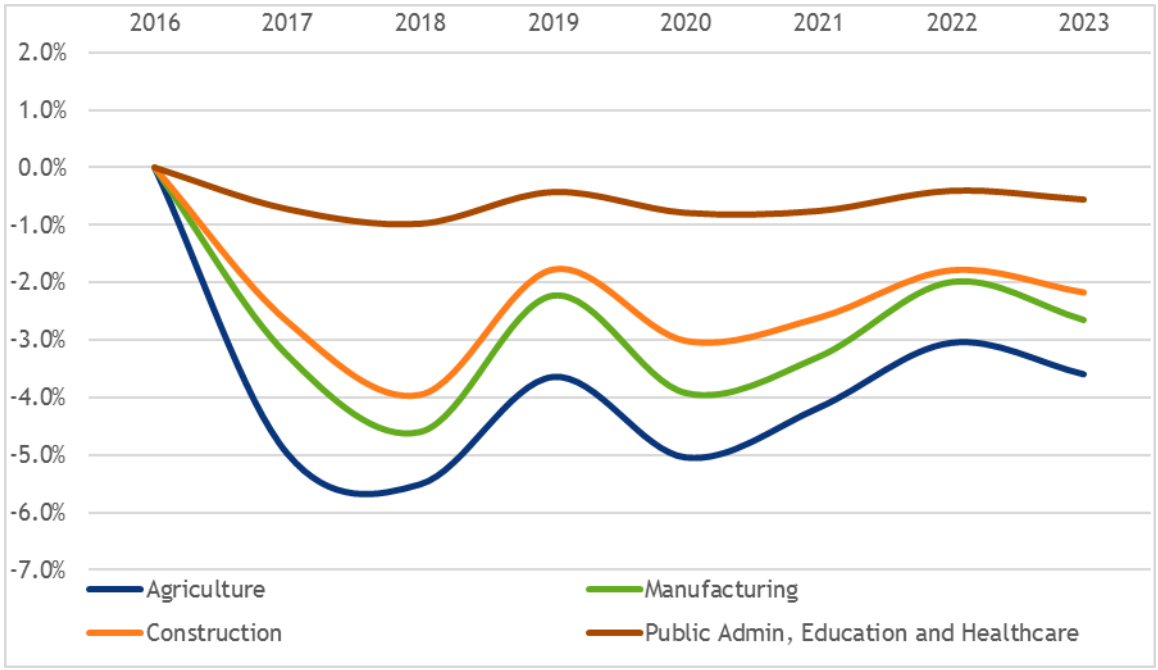
To gain a better understanding of the impact of the adoption of digital technologies, it is worth looking closer at key economic sectors. These have been identified as Agriculture, Manufacturing, Construction and the delivery of Public Services. These sectors cover enterprises that are both heavy and light investors in digital technologies, employ most of the workforce in Ireland, and account for the greatest number of enterprises in terms of size. For the sectoral analysis the mean risk of probability from studies and the upper and lower estimates have been used (Table 6 and Figure 11).

Table 6: Workforce Growth Including the Impact Adoption of Digital Technologies – Selected Industry Groups (000s)

NACE Economic Sectors	2018	2019	2020	2021	2022	2023
Agriculture	102.4	104.4	102.2	103.7	105.3	104.6
Year-on-year change	-0.4%	1.9%	-2.1%	1.4%	1.5%	-0.6%
Manufacturing	233.1	257.8	259	266.9	276.8	280.6
	-4.2%	10.6%	0.5%	3.1%	3.7%	1.4%
Construction	139.9	145.3	152.7	161.9	171.7	179.3
	7.8%	3.8%	5.1%	6.0%	6.1%	4.4%
Public Admin, Education, Healthcare	552.6	568	577.2	588.6	601.8	612.1
	1.1%	2.8%	1.6%	2.0%	2.2%	1.7%

Source: IDC estimates 2018

Figure 11: Percentage of Workforce Displaced by the Adoption of Digital Technologies 2016–2023- Selected Industry Groups



Source: IDC estimates 2018

The risk to sectors will vary depending on the makeup of the occupations within that sector and the specific tasks that those occupations undertake. Similar occupations can, in effect, have different tasks depending on the nature of the sector.

6.6.1 Agriculture

The agricultural sector is expected to employ approximately the same number of people by 2023. This is a continuation of the trend observed over the past decade, if not longer. Employment in the sector has declined from a peak of over 140,000 in the late 1990s to around 108,000 in 2017. However, output in the sector is expected to continue to rise, indicating that the sector will continue its long-term shift towards becoming an increasingly capital-intensive, higher productivity sector.

Farmers continue to account for the largest percentage of employment across Agriculture, making up 80% of all employment in the sector. Agricultural labourers account for a relatively small amount of employment, at only 10% of all employees. The agricultural sector is likely to experience disruption in a different way to other industries. It is more likely to adopt a broad set of technologies, not just automation tools for improving farm management systems. The sector is also investing in sensing and IoT tools to help with machine maintenance performance, automation of farm equipment and robotics.

However, the sector tends to be dominated by smallholdings, so the adoption of digital technologies is only likely to benefit a few of the larger players in the market. Adoption by larger farmers could make it uneconomical for smaller, less cost-competitive farmers to compete and result in reducing the number of active farmers. Other barriers to adoption that may exist include broadband accessibility, farm profitability, farmer age and education level.

The methodological differences between the different studies makes it difficult for comparison, and there are likely to be differences with forecasts for this sector; the exclusion of occupations that do not use ICT in the F&O model will have an impact, the PwC study did not provide any details on agriculture so it is not clear if this sector was covered. This could lead to an over estimation of high risk for that industry.

6.6.2 Construction

The Construction sector is under pressure to address the growing housing shortage. Investment in infrastructure and commercial developments has been strong, while investment in housing has been weak in comparison. The build-up of demand may create additional labour demands. The demand for labour could be further stimulated by the strengthening economic situation. Rising incomes could create demand to modernise existing properties as well as increase demand for higher quality buildings. Despite the existing demand for labour, the ability of the sector to attract new workers continues to cause some concern.

The upshot of this has been a gradual change to the distribution of occupations across the sector. The need to satisfy demands could lead to an increased demand for labour in the sector, and not just within manual jobs. As commercial and infrastructure construction has driven much of the

growth in the sector, it is no surprise that there has been a been a bigger demand for roles such as managers and those related to the different construction techniques used, such as construction operatives, fitters and electricians. That being said, the non-manual roles that have increased over the past decade are most at risk from disruption from digital technologies. Those areas most at risk over the forecast period include associate professional and technical occupations (71% at high risk of disruption), process, plant machine operatives (60%) and unskilled labour (60%).

6.6.3 Manufacturing

The Manufacturing sector in Ireland has undergone significant change over the past two decades in response to shifting global demands for goods and increasing competition from emerging countries which have competitive advantages due to access to large amounts of cheap labour. In response, the manufacturing base has had to pivot and focus on high-tech areas such as ICT, medical devices and pharmaceuticals.

This shift has been accompanied by an investment into new ways of working through leaner business and production processes enabled by ICT. Many manufacturing floors already have a higher than average level of automation and robotics than are found in other sectors. Further automation will no doubt have an impact on the sector, but the impact will be lower than if the sector was at a less mature stage. In fact, further investment could make the sector more competitive in comparison to other EU countries.

This will also impact the type of skilled workforce required in the sector. High tech manufacturing requires occupations with a higher cognitive function, such as technicians, ICT engineers, managers and process engineers. Disruption across occupations will therefore be more keenly felt in areas associated with process, plant and machine operatives and skilled trades.

6.6.4 Public Service

Ireland, like many other Western European economies, has seen employment levels across the Public Administration, Education and Healthcare sectors grow. The impact of the global recession in 2008 forced governments to look at how they can deliver public services for less without impacting on the quality of services or outcomes for citizens. This has often been accompanied by a push to reduce the overall size of the workforce employed across the sector by keeping increases in wages below national averages and restricting recruitment where possible.

The sector has often been considered ripe for automation due to the nature of many of the roles and tasks undertaken. However, many of these roles also require significant interaction with citizens who often have complicated cases. The public sector also tends to employ a higher number of professionals, especially in the Education and Healthcare sectors.

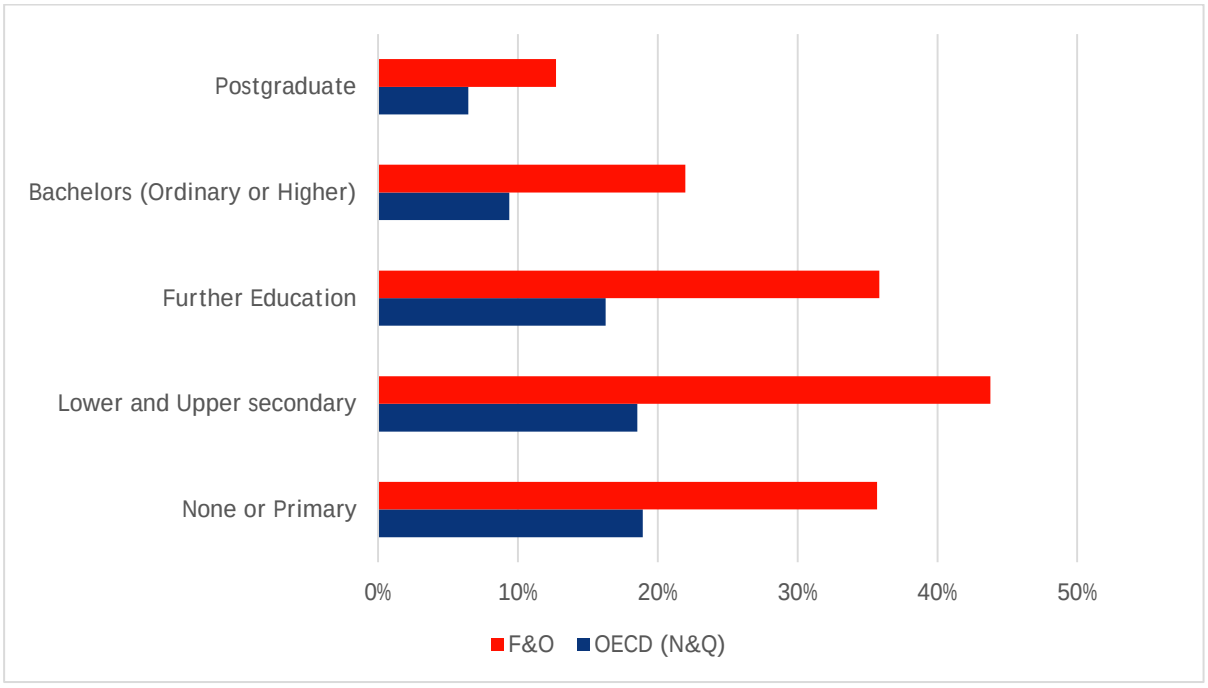
6.7 Adoption of Digital Technology and the Impact on Workers by Education Level

The educational attainment of the workforce plays a significant part in the future probability of roles being at risk of erosion from automation and digital technologies. Elementary-based roles are assumed to consist of repetitive, manual tasks which overall do not require higher levels of education. Therefore, it is expected that these roles would be the first to decline.

The demographics of the Irish workforce adds to this expectation. In the last Educational Attainment Thematic Report by the CSO, in February 2018, people aged 25-64 years old with a third level qualification were more than twice as likely to be employed (85%) than those with no formal education/primary education (35%). Similarly, those aged 25-64 years old with only primary education or below were over three times as likely to be unemployed.[18]

To achieve a current view into workforce structure, the educational attainment of employees by occupation in 2016 has been mapped against the risk from the impact of automation. When comparing the probability for automation of occupation by educational attainment for F&O and OECD, although they predict very different levels of impact, both indicate that the higher the level of educational attainment the lower the probability of that job being displaced by digital technology.

Figure 12: Potential Impact of Automation by Educational Attainment for Ireland- Employees Across All Industries



Source: F&O, OECD data and IDC estimates

[18] Educational Attainment Thematic Report, CSO Ireland. Available from: https://www.cso.ie/en/releasesandpublications/er/eda/educationalattainmentthematicreport2017/

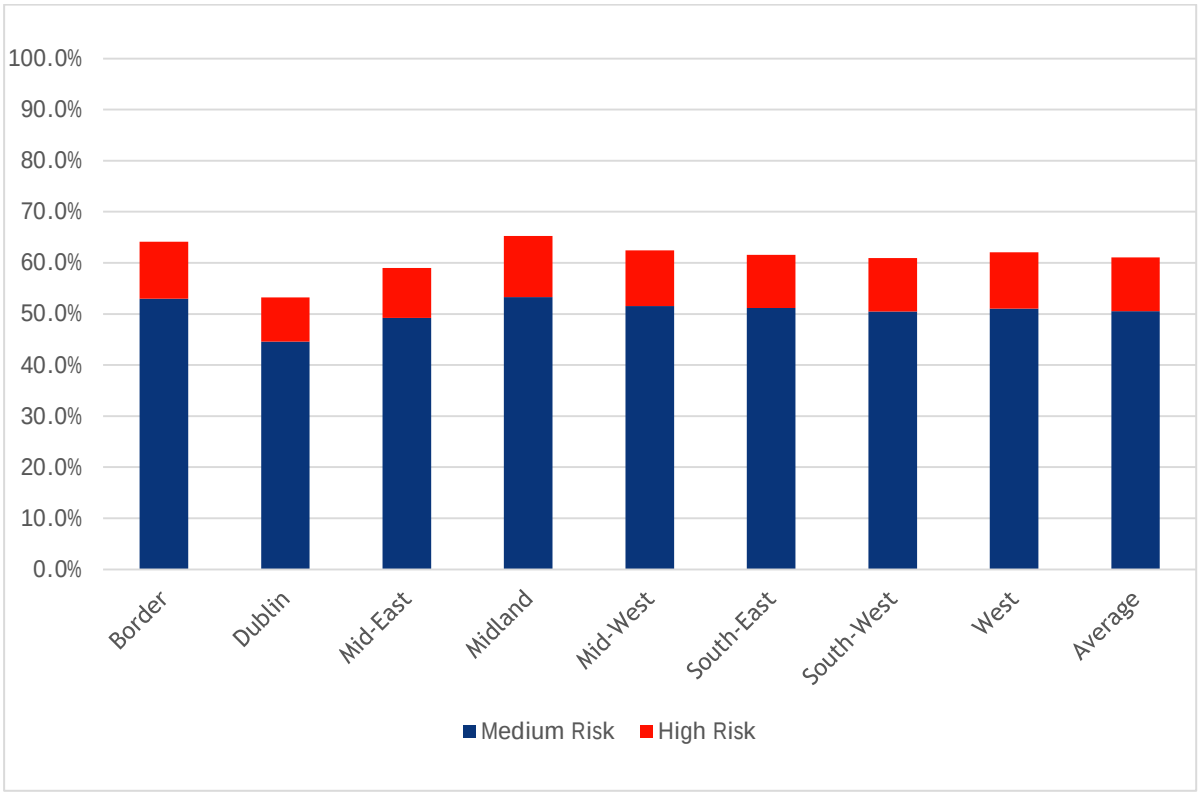
It should be noted that Ireland is currently facing a challenge around staffing levels in the education sector. The slowdown in the demographic growth in younger age groups indicates that there could potentially be less demand for primary teachers and an increased demand for lower and upper secondary teachers. This could impact employment in both sectors.

6.8 Impact on Regions

Diversity of the sectoral base helps protect regions from short-term downturns and impacts of external changes to demand. The limitations of Ireland's geography and population present challenges to the adoption of digital technologies. This will help to insulate some regions from the impact such as Dublin, which has a diverse sectoral and labour base, but could potentially negatively impact others disproportionately.

Overall, it is estimated that the impact of the adoption of digital technologies will cut 0.27% of overall growth in jobs between 2017 and 2023. An average growth in the workforce of 2% across the regions is predicted, rising from 2.16 million in 2016 to 2.49 million in 2023. The analysis indicates that the impact from digital technologies could reduce this to 1.7%, rising from 2.15 million in 2016 to 2.44 million.

Figure 13: Regional Variation of Risk from Automation



Source: IDC estimates

Figure 13 highlights the risk of automation across the regions based on the mean rate of impact from the adoption of digital technologies. The analysis indicates that the regions with the highest

proportion of workforce at risk are the Midlands at 12% and the Border at 11%. Dublin was found to have the lowest proportion of workforce at risk. At just 9%, Dublin falls below the average for all regions, which is 11%. This is no surprise given the diverse nature of employment in Dublin and the abundance of sectors that are at low-risk of impact from automation.

When adding in those at medium risk, the picture remains largely unchanged. The total at risk across the Midlands is 65% and for the Border it is 64%. Again, Dublin is the region least at risk with 53% of the workforce at medium or high risk. It is concerning that the regions most at risk are those which have already faced considerable labour pressures due to their reliance on sectors that have suffered since the recession of 2008. It is possible these regions will find it hardest to resist further change. Their ability to respond will be critical to avoid an acceleration of the erosion of jobs.

Chapter 7: The View from the Stakeholders

In addition to the detailed quantitative analysis, a further key objective of the research was to obtain input from stakeholders. The purpose of these interviews was to corroborate the results of the economic model and to inform the research on the future policy implications. Two groups of stakeholders were engaged as follows:

- Enterprises and Representative Bodies/Other
- The Regional Skills Fora

To further understand the current impacts of digital adoption on the workforce a small number of employee, interviews were carried out to provide a brief snapshot of their experiences of digitalisation/automation. The results of these interviews are detailed in section 7.5.

Important Note on Sample Size

The research findings in this section of the report are based on in-depth interviews with a small number of key individuals who have detailed knowledge of specific areas under investigation in the project. A small number of quantitative, closed questions were included. Though the results of these questions have been presented in graphic format, this is not to suggest that they are fully representative but merely provide a guide to the opinion of this specific group.

7.1 Enterprises

The enterprise perspective was obtained through interviews with ten key informants. When drawing up the target list for the enterprise interviews, respondents were identified to give a view of their sector as distinct from just their own organisation. Specific sectors considered to be particularly susceptible to the impacts of digitalisation/automation were chosen, including:

- Construction
- Customer Services
- Financial Services
- Manufacturing
- Marketing
- Pharma
- Retail
- Security/Cyber defence
- Software/Computers
- Transport

7.2 Representative Bodies/Other

Five further interviews were undertaken with representatives of stakeholder organisations including academic institutions, government agencies such as the IDA and Enterprise Ireland, industry representative bodies and other individuals selected for their knowledge and expertise on the likely impact of automation on jobs. These in-depth interviews were conducted by phone with the questioning being primarily, but not exclusively, qualitative in nature.

7.3 Enterprise Interviews — Results and Analysis

7.3.1 Stage of Digitalisation/Automation

Early questions sought to establish what digital technologies were being used in individual sectors. The responses suggested that the process of digitalisation/digital transformation was ongoing across the board and comprised the use of many of these technologies in many sectors. Many things can influence the speed at which they are adopted in a sector.

The marketing sector, for instance, had digitalisation thrust upon it by the activities of the major internet firms, most notably Google and Facebook. It experienced major change quickly with the impact exacerbated by the recession in Ireland over the past decade. It is the exception however, with developments in other sectors, such as Construction, happening more slowly. The way contracts are put together, with many organisations and individuals being involved, acts as a barrier to the use of building information modelling (BIM) systems, for example. Things are changing in the sector, but there is a recognition that progress will be slow. This has been identified earlier in this report that numbers employed in the sector are expected to grow significantly in the coming years due to the extent of demand for housing. In other sectors, the picture is mixed.

Ireland has a strong presence of multinational technology firms that develop digitalisation and automation solutions for customers around the world, which means that there is much knowledge and expertise in the country. This doesn't automatically mean our technology adoption profile is as it should be. A major survey of Irish businesses in 2017 found that many were at a comparatively early stage of adoption of digitalisation and automation. [19]

One sector where change is underway is Financial Services, and a lot more is expected as its digital transformation journey continues. A respondent from this sector suggested that the past four years have seen firms in Ireland make the cultural changes necessary for digitalisation, while the next few years will see them realise the benefits. Pharmaceuticals is another sector where digital technologies are set to revolutionise the sector in due course. Companies in this sector tend to have very traditional IT systems and face the challenge of integrating these with newer technologies to optimise the benefits they can achieve.

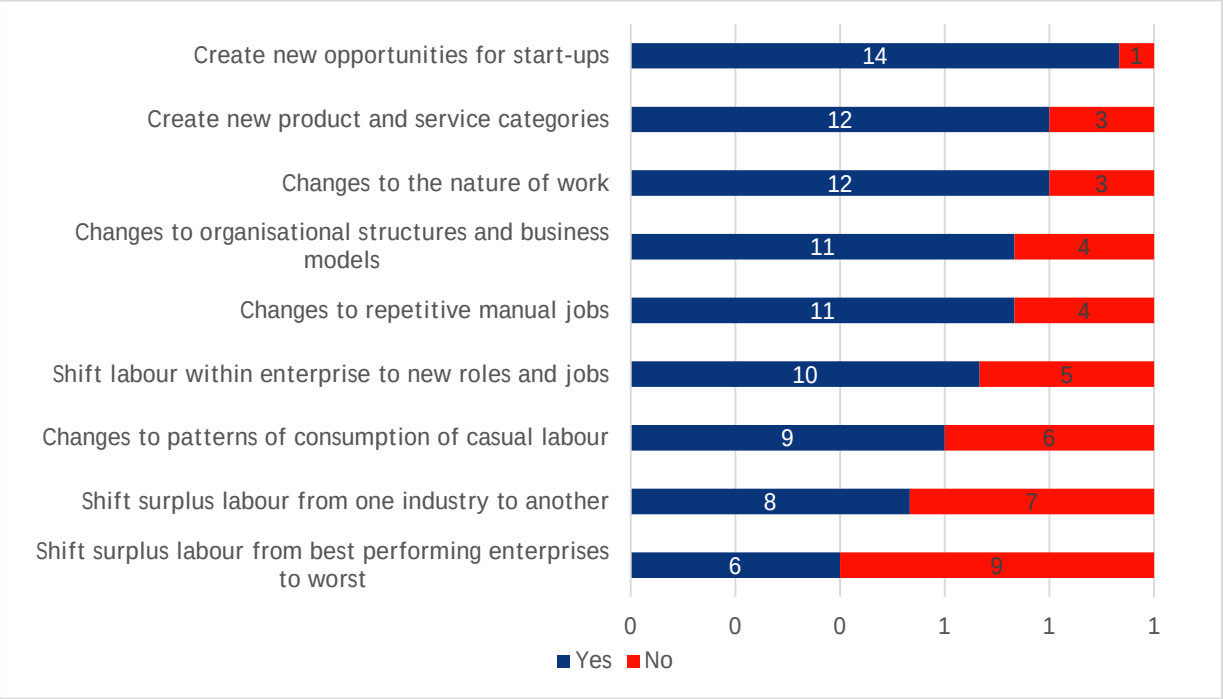
[19] Digitalisation: Unlocking the potential. Digitalisation Survey Ireland, Findings Report. Siemens, 2017.

With the current level of labour-intensive activity in the business (in areas such as clinical trials) there is great scope for it to catch up and be ripe for automation. However, while both Financial Services and Pharmaceutical sectors will experience significant job losses in the fullness of time as automation is rolled out, there is no expectation that this will happen within the 2018–2023 timescale. In fact, moderate employment growth is forecast for financial services during this period.

7.3.2 Specific Impacts

To get a sense of the influence the use of these technologies will have, respondents were given a list of options and asked which would be likely impacts of the development of AI, Big Data and Analytics, robotics and automation in their industry. The key areas of impact identified by the respondents were changes to the nature of work, to organisational structures and business models and changes to repetitive manual jobs. This is borne out by the findings of interviews with employees who have experienced digitalisation/automation within their organisations already, as is detailed later in this section

Figure 14: Impact of Digitalisation/Automation



Number of respondents =15

NB: Readers should note the small sample size when making assumptions based on this data.

Source: IDC, 2018

7.3.3 Job Roles at Risk

The next section of questions focused on the changing nature of work in each sector, what job roles might be at risk and which new ones might be created. The findings from the interviews support

that the jobs most at risk are expected to be low-level, low-skilled roles. In time, autonomous vehicle usage will result in job losses for drivers of all types from taxi drivers to people doing parcel deliveries. This will impact many sectors, not just transportation. Tradespeople will also be required in smaller numbers, which will see job losses in areas like Construction and Manufacturing. People whose jobs involve manual data entry will be under threat in sectors such as Financial Services, Retail and Pharmaceuticals. Respondents considered the level of jobs risk in the ICT/software sector to be small, with software testing being the only area perceived as under threat.

7.3.4 New Job Roles

In terms of new roles likely to be created as a result of the move to digitalisation and automation a number of respondents indicated that while some current call-centre roles may diminish, new customer service roles will be created. These will be seen in sectors like Retail and Financial Services, where customer service will be become more specialised, require higher-level skills and, potentially, educational qualifications. There will be a need for people in new roles to work with data in many sectors. Data scientists and data analysts will be needed and data management jobs will be created. Though not a new role, there will be a requirement for many more software developers in a range of sectors.

7.3.5 New Roles — Existing Workers or New Hires

In all sectors there will be a requirement to bring in some new people with new skills, particularly since some of these new roles are in very new disciplines such as data science. The marketing sector is addressing this challenge already where people who can upskill are staying in the sector and adapting. There are also new people coming into the sector who are inexperienced but naturally empathetic to the digital platform. In financial services, widespread hiring for new roles is expected.

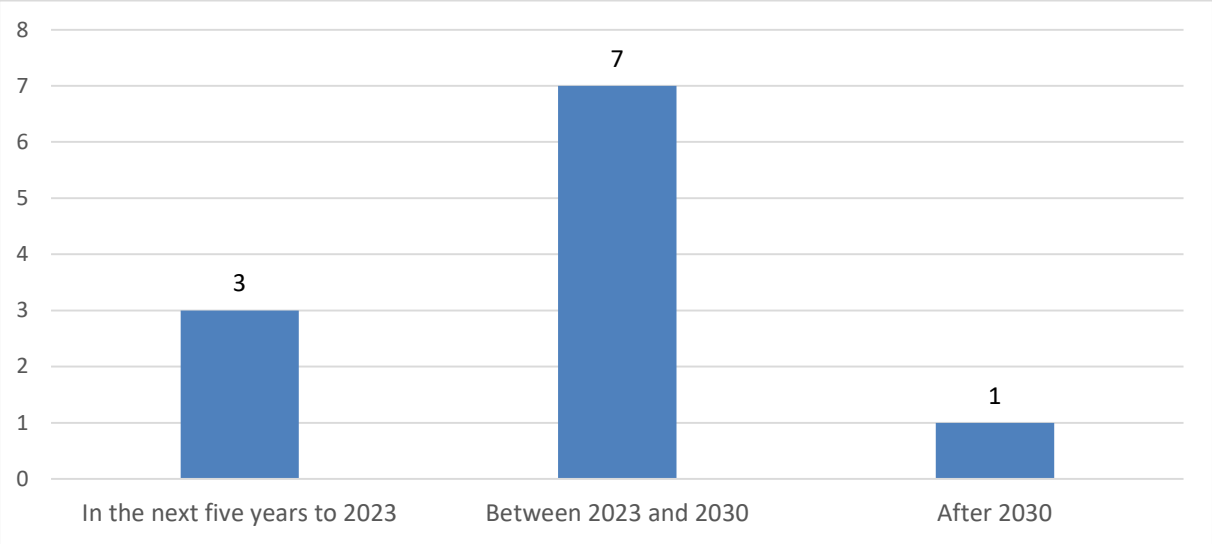
7.3.6 Potential for Retraining

The potential for existing workers to be retrained in new roles will vary across different sectors. Respondents in the contact centre, retail and ICT/software industries were confident that it would be possible for the majority of people to retrain with new skills as required as automation develops. In Construction, the outcome will depend very much on the capacity of individuals to adapt. Some people will adapt to the new environment, while others won't. Soft skills, which help people to adjust to a new organisational structure in the sector, will be a key differentiator. In the financial services and pharmaceuticals sectors, respondents were more negative about the potential for existing workers to be retrained for new roles. These sectors include many workers who do manual, repetitive jobs which will be ripe for automation in the medium to long term.

7.3.7 Timescale for Jobs Impact

Respondents were asked to indicate which period of time they thought would see the biggest negative impact on jobs in their industries as a result of digitalisation/automation. Just three respondents expect that the major impact to their sector will be seen in the next five years. One is in marketing, one in the contact-centre sector and one in the Construction sector, who further suggested the creation of new roles has had a positive impact.

Figure 15: Perceived Timescale of Jobs Impact



Number of respondents =11 (remainder expect jobs to increase)

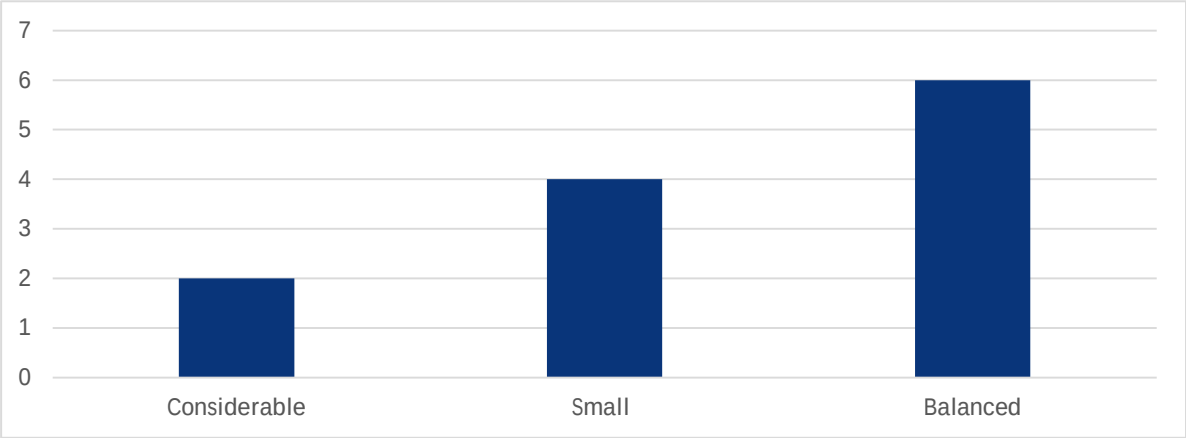
NB: Readers should note the small sample size when making assumptions based on this data.

Source: IDC, 2018

7.3.8 Long Term Jobs Impact

The next issue to address was that of the long-term impact on jobs in Ireland. Respondents were asked whether, by 2030, they thought their sector would have suffered a considerable loss of jobs, a small loss or experienced a balanced outcome where the number of jobs created was equal to the number lost. Figure 16 shows that half expect a balanced outcome. It should be stated that some respondents suggested that a balanced outcome was aspirational and could only be achieved if certain measures were implemented (e.g. retraining).

Figure 16: Perceived Long-Term Jobs Impact



Number of respondents =12 (remainder expect an increase)

NB: Readers should note the small sample size when make assumptions based on this data.

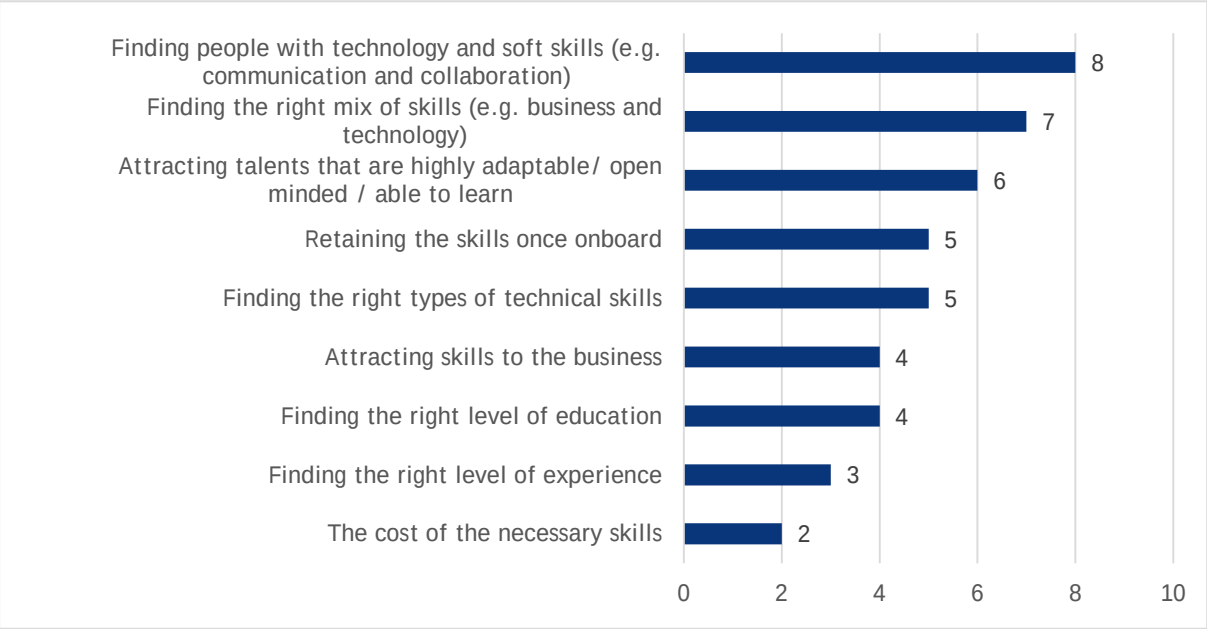
Source: IDC, 2018

It could be concluded that, in some of the sectors where respondents have indicated there can be a balanced outcome, there are indications from other research that there are more likely to be job losses and that in some cases the numbers are likely to be high. In the Transport sector in the era of the autonomous vehicle, for example, it is easier to envisage the kinds of jobs that are likely to be lost than the new ones that might be created. Similarly, in Construction, factors like prefabrication and the use of BIM systems will have a substantial impact on the sector over time. The likely impact on a range of job roles from the deskilling of tradespeople to the automation of quantity surveying is easier to predict than to assess what numbers of new job roles will come into existence. When measured in absolute numbers of people, it is difficult to see how some net loss of jobs could be avoided.

7.3.9 Challenges in Sourcing Skills

Since it is likely that organisations will need to acquire new skills to help them optimise their journey to digitalisation/automation, respondents were asked to identify which three from a list of options they expected to be the biggest challenges faced in terms of acquiring these skills. The distribution of responses is very interesting. Skills shortages, especially in the ICT sector, are leading to cost issues and the retention of skilled workers is a major challenge which is potentially set to worsen. However, this is not reflected as a key issue in the responses to the survey.

Figure 17: Top 3 Challenges Faced Acquiring Skills



Number of respondents =13

NB: Readers should note the small sample size when making assumptions based on this data.

Source: IDC, 2018

The biggest challenge identified by the respondents is finding people with technology and soft skills such as the ability to communicate and collaborate effectively. The next highest-rated challenge is linked in that it refers to a mix of technology and business skills. The third highest option suggests that attracting talented people who are highly adaptable, open-minded and ready to learn new may be more difficult going forward. The digital world will challenge people to be flexible and aware that over the span of the working lives they will have to learn new things and take on many new roles.

7.3.10 Policies and Actions

In the final section, questions were posed to respondents regarding the policy actions they thought were needed to address the requirements of the digitalisation/automation age, and in particular the negative impact on jobs. What should the Government do about the possible negative impacts of digitalisation/automation on jobs? Respondents were asked for suggestions.

7.3.11 Retraining/Reskilling

Most of the suggestions provided by respondents are in place already in the form of government programmes and initiatives. Unsurprisingly, most recommendations centred on retraining and reskilling. It was expressed that private and public institutions should be involved and that it may also be time to evaluate the education and training system. Companies could be incentivised to prepare their employees for when their jobs are automated, while employees ought to be

incentivised to engage in retraining also. Respondents suggested that the Government also needs to ensure that people have at least basic technological capabilities for employment in the digital era. People who cannot use the internet are much less employable. The importance of early intervention in retraining was stressed.

Many of these concerns are being addressed already. Opportunities to upskill or reskill can take a range of forms including on the job training, short courses, industry certification and formal education and training programmes. Among the programmes and initiatives currently provided by Government are:

- Springboard+ which allows people to upskill or reskill in areas of identified skills need. Courses cover a wide range of subjects. Formerly targeted at unemployed people in need of upskilling, Springboard+ courses are now being made available to all people irrespective of employment status.
- Supporting Working Lives and Enterprise Growth in Ireland was published by SOLAS in June 2018, setting out a new policy framework for employee development opportunities in Ireland. The policy includes goals and targets for the period 2018- 2021.
- eCollege which delivers online and distance training courses across subjects targeted at jobseekers, employees and employers.

The Regional Skills Fora Managers have recently developed and are piloting the EXPLORE Programme which is aimed at upskilling the existing workforce and improving Ireland's lifelong learning rates. The key objective of the initiative is to create a potential new solution to help address the issue of Ireland's low level of participation in lifelong learning amongst the workforce, particularly targeting persons over 35 years of age employed in manufacturing. Among other aims, it seeks to address the lack of digital skills in this cohort; provide a novel approach to overcoming barriers to participation in lifelong learning; and address the key issue of skills obsolescence which is a significant concern for employers.

7.3.12 Lifelong Learning

Another linked theme suggested by respondents was the idea of continuous lifelong learning which would align programmes with requirements. This would enable action to be taken to reduce future impact on jobs. Training and development should be ongoing, with all personnel taking a number of courses every year, some in-house, some external. This is being addressed by the Government in the National Skills Strategy 2025. Ireland currently has a lifelong participation rate of 8.9%[20] and increasing this figure is a key aim of a number of policy documents and initiatives.

[20] Adult participation in lifelong learning by sex, Eurostat, 2017

7.3.13 Soft Skills

Many of the respondents suggested that changes may be needed to the education and training system at primary and secondary level, with a greater emphasis on soft skills. This too is being addressed by the National Skills Strategy. Its aim is that students at all stages of education and training will be taught a strong mix of transversal skills and subject knowledge. Transversal skills are sometimes referred to as employability skills, soft skills and transferable skills. They can refer to a wide range of skills such as communications, creativity and problem solving.

7.3.14 Apprenticeships

The importance of apprenticeships was a point of focus for respondents, and work is under way in this area. As called for under the National Skills Strategy 2025, the expansion of industry and apprenticeship participation and the development of new industry-led apprenticeships is well underway through the Action Plan to Expand Traineeships and Apprenticeships 2016-2020. The Action Plan aims to significantly grow work-based learning over the coming five years using the apprenticeship and traineeship models of learning and skills development. It provides a framework for a range of agencies and government departments to address the relevant needs for upskilling and reskilling. This framework can be used to reduce the potential negative impacts of digitalisation/automation on the workforce.

7.4 Regional Perspective

Regional Skills Forum managers provided perspectives on the extent to which digitalisation/ automation is having an impact on the companies they are engaging with in their regions.

- The Regional Skills Fora reported that current usage of automation is mixed but most prevalent in the manufacturing sector (primarily in the multinational FDI sector one may assume). Medtech, Life Sciences, Pharmaceuticals and Food are included in this, but there is also usage to a lesser extent in ICT, Financial Services, Hospitality, Retail and Logistics.
- Among the range of digitalisation/automation technologies used, robotics is the most prevalent. However, there is investment in big data/analytics and artificial intelligence also.
- Change is happening at the manufacturing process level, where greater efficiency is the goal and where robotics is playing a part. In sectors such as Retail and Financial Services, client management is an area where digitalisation/automation is being used.
- Respondents expect that in the coming years most manufacturing sectors will be impacted, as well as Aviation, Retail, Financial Services, Construction and Agritech. However, the timescale for each is less clear, though change in the Hospitality sector may take longer.
- The reshaping of job roles is very clearly taking place, but the jobs impact is less clear. There is evidence that, in the positive economic environment, growth is allowing companies to improve productivity, which is offsetting jobs risk. Reskilling and upskilling are ongoing.
- With regard to continuous or ongoing training and who provides it, there is a very mixed picture in different regions/industries. Large firms are more likely to be engaged in continuous training, using a mix of private and public training providers. High tech sectors (e.g. ICT, Fintech) are

better at engaging with local training provision than lower tech (Retail, Hospitality). Upskilling is a popular component of staff retention.

- There is a vast array of technical skills in demand in different industries. Digital skills will be required by more people too. Soft skills are also very important to help people upskill and retrain. Many job roles will need to upskill.

7.5 Employee Perspective: A Snapshot

To provide a further element to this study, a small number of employee interviews were carried out to provide a snapshot of how the adoption of digital technologies is currently impacting jobs in Ireland. The interviews sought to assess to what extent employees' roles were changing and how they felt about the change. In total, seven respondents were interviewed from a range of sectors and departments within organisations. Two worked in the public sector, the remainder in private sector firms. The following text represents a summation of their views on the resulting impacts from technology adoption.

In most cases, the implementation of the particular technology was aimed at increasing efficiency. For some respondents the adoption of technology has acted to automate tasks that were previously done manually. This has freed up time as a consequence, and routine tasks have been replaced with more intuitive, problem-solving activities. In cases where the respondents were in customer service roles, the investment enabled a better experience to be provided to customers. One respondent in a manufacturing firm suggested their role had changed totally when a new touchscreen production system was introduced.

When the respondents were asked how the technology has impacted the number and type of tasks they perform there was a range of responses. In some cases, repetitive, time-consuming tasks had been eliminated, leading to a more efficient system. However, none had seen a change in their working hours as a result of their adoption. The majority of respondents consider that despite these improvements in efficiency there hadn't been a major cultural change in their organisation.

Many of the respondents were required to receive training on new technologies, with an ongoing training requirement for some going forward. In most cases the training was carried out in-house and was not disruptive to their work. All respondents indicated that they were able to adjust to working with new technologies without much difficulty, though one suggested that some of their older colleagues found the transition more challenging.

All respondents claimed to have approached the changes with a positive mindset. Some faced challenges along the way but ultimately adapted well. Some indicated that their older colleagues were more concerned about the adoption of new technologies than younger employees. All respondents claimed to still feel positive about the changes that the technology investment has brought to their organisation and their role within it. Some identified that they had been upskilled as a result.

None of the respondents had been made redundant or seen redundancies in their respective organisations as a result of the adoption of new technologies. When asked if they now felt more secure in their jobs there was a range of responses. Most felt more secure because they had been upskilled, while some felt that in time they might lose out to automation. Two of the seven respondents indicated that they could see how redundancies within their organisations could occur at a later stage as a result of automation.

Chapter 8: Policy Implications and Key Challenges

There are a number of areas that the Government ought to address in the light of the likely impact of the adoption of digital technologies across different sectors and occupations. This is based on analysis of the ideas and suggestions for future actions provided by the stakeholders and of the publications reviewed in the desk research phase. In addressing these issues Ireland has the opportunity to maximise the benefits arising from the adoption of digital technologies.

Ireland faces two significant challenges over the next five to ten years. Firstly, the large established companies in Ireland at the technology frontier will continue to automate tasks to remain competitive in the face of increasing challenges and consumer demands. At the same time, automation will be impacting traditional sectors that once might have been thought to be on the fringe of technological change but are now finding robotics and automation being more rapidly adopted, such as robotic fruit-pickers on farms. Increasingly, it will not just be the low skilled, manual jobs that are at risk. Mid-tier management roles will also be at risk of automation. A larger number of workers will struggle with changing skills demands and potential job losses.

This combination of challenges will require a response that moves beyond individual changes aimed at making incremental differences. This requires Ireland to take a coordinated, multisector approach that includes both public and private enterprises to advance the benefits of adoption, and also to ensure that employees have access to skills and knowledge resources that will support them through the changes so that Ireland's economy continues to grow and expand for the benefit of all. If Ireland can effectively mobilise its resources and smooth workforce transitions it will have the opportunity to take full advantage of the economic and social benefits arising from the increased adoption of digital technologies.

Over the next five years 4% of jobs in Ireland are forecast to be at high risk of disruption from the adoption of digital technologies. When those at medium risk are added the number rises to 43%. The impact of adopting digital technologies will not be spread evenly across sectors or regions. The methodology used attempts to replicate the historical adoption of technology by sectors in combination with a probability of automation by occupation within those sectors. If the individual enterprises across a given sector move quicker to adopt digital technology, then the rate of impact would accelerate and the disruption to the sector and or region would be greater.

8.1 Sectoral Impact from the Adoption of Digital Technologies on Ireland's Workforce

As addressed earlier in this report, the adoption of digital technology will not impact all sectors equally. The risk of automation and its impact on a sector depends on numerous factors, including technological infrastructures to facilitate adoption, the occupations most prevalent in a sector and the skills needs to fill roles. This section provides examples of how different sectors will be impacted by digital technologies, and what is being done to minimise these impacts going forward.

8.1.1 Agriculture

The agricultural and wider bioeconomy sector is of significant importance to the Irish economy, but its future very much depends on long-term planning. This EGFSN report estimates that 12% of this workforce are at high risk, and that a further 86% are at medium risk from the impact of digital technologies. The Department of Agriculture, Food and the Marine has identified the need to harness technology to meets its long-term economic and environmental targets through the Sustainable Healthy Agri-food Research Plan (SHARP). The European Union has also issued a number of new policies, such as the European Innovation Partnership for Agricultural Productivity and Sustainability, and the EU Bioeconomy Strategy, that are addressing the modernisation and digitalisation of the sector.

There are factors which might delay the impact of the adoption of digital technologies. In the case of agriculture and the bioeconomy, innovative technologies need to be customised, integrated and tested. Additionally, the sector does not traditionally have strong technological infrastructure. Broadband connectivity of speeds comparable to the cities is rare and this factor alone could delay the uptake of certain technologies. These issues are not unique to Ireland, and there are already plans in place to support the development of the agritech industry in Ireland. Currently both industry and Teagasc are involved in research on the potential of the adoption of digital technologies for the sector and it is expected that the rate of uptake by farmers will accelerate in the coming years.

In 2017 the Ireland Strategic Investment Fund (ISIF) invested €20 million into venture capital firm Finistere Ventures to invest in agriculture-technology start-ups. Waterford Institute Technology (WIT), Teagasc and University College Dublin (UCD) are also playing an important part in the digital transformation of the agri-food sector in Europe. WIT, Teagasc and the Irish Farmers Association have been chosen as part of a €20 million SmartAgriHubs project. The project aims to build a pan-European network of Digital Innovation Hubs (DIHs) and Centres of Competence across all 28 European Member States. The hubs will be a way for farmers, advisors and agritech SMEs to engage with research centres and research-active higher education institutions to develop new technologies for the sector. The Agriculture sector could potentially act as an example for how sectors can access funding and work collaboratively to turn digital technologies into an opportunity for expansion and growth.

8.1.2 Manufacturing

The impact from digital technologies will have both positive and negative consequences for the manufacturing sector. 3D printing, for example, allows manufacturers to prototype items faster than before and with less investment. Investments by firms into 3D printing means that many enterprises could soon start to print much of what they need rather than ordering it from manufacturers. The combined effect of these will lead to many occupations being at risk. This report estimates that 21% of occupations are at high risk, with a further 65% at medium risk. Occupations associated with processing and operations are at risk, especially those associated with manual work, such as packing and filling machine operatives. The fact that manufacturing will be

one of the sectors at high risk will have implications for Ireland in that much of foreign direct investment is in the manufacturing area.

The Government has a number of policies in place focusing on manufacturing. The Action Plan for Jobs 2018 called for the development of an Industry 4.0 strategy that responds to the specific opportunities and challenges for the manufacturing sector arising from the impact of digital technologies. This is currently underway and is expected to be completed by the end of 2018.

Furthermore, the EXPLORE programme as developed by the Department of Education and Skills, aims to help address the issue of Ireland's low level of participation in lifelong learning, particularly targeting persons over 35 years of age in manufacturing. Skills to Advance, a new campaign from SOLAS aimed at developing the skills of people in employment, was launched in September 2018. It identifies manufacturing as an area where upskilling can impact significantly on earning capacity and security. In addition, the EGFSN published the study 'Future Skills Needs of the Biopharma Industry in Ireland' in 2016, which identified the growing role of manufacturing across the Biopharma sector and the requisite skills needs. The Government will need to continue to monitor developments in both indigenous and multinational firms based here to be as proactive as possible in taking steps to minimise the impact.

8.1.3 Retail, Transport and Hospitality

The Retail sector globally has suffered from the rise of new, disruptive vendors into the market such as Amazon and eBay. While these new enterprises have created jobs, the long-term view is that further advances in robotics and automation technologies will mean fewer workers in warehouse, shop-floor and delivery roles. This report found that 76% of workers have a medium to high probability of being impacted by digital technologies in the Retail, Transport and Hospitality sector. The research indicates that the occupations most at risk are those that fall under the heading of sales and customer service and primarily they will be low-skilled roles. The roll-out of digital technologies is happening slowly in the Retail sector and even more so in the Hospitality sector. However, in the medium to long term it will have a detrimental impact particularly on the regions which are heavily dependent on tourism for employment.

The Action Plans for Jobs have had a number of actions in relation to the Retail sector over the past years in order to improve skills and respond to the changing digital landscape. For example, in 2017 the Action Plan for Jobs called for the development of a pilot training programme to support retailers to scale up their online trading activity and expand into international markets. As a result of this, Enterprise Ireland developed a pilot scheme to support retail SMEs develop or enhance their online presence with a view to expanding internationally. In the Action Plan for Jobs 2018 it was acknowledged that the uptake of digital technologies needs to be further encouraged in the Retail sector. Action 41 commits to the expansion of the Trading Online Voucher Scheme from the target of 1,000 in 2017 to 1,500 in 2018. Budget 2019 also announced supports for the digital online capability of the Retail sector. A €1.25 million scheme is being rolled out to be delivered in two competitive calls supporting Project Ireland 2040 commitments.

In 2015 the EGFSN published an 'Assessment of Future Skills Requirements in the Hospitality Sector in Ireland, 2015-2020'. The report focused on current and future skills demand in the sector and put forward recommendations to promote and develop skills in the sector. Amongst these recommendations was the development of a National Oversight and Advisory Group. This oversight group published their final report detailing the progress made in the sector in September 2018. The final report demonstrates that the promotion and development of skills is now being pursued through a number of different outlets, including Skillnet Ireland and the development of apprenticeship and traineeship programmes in the sector.

The adoption of digital technologies is changing the way that people travel. New technologies are enabling the exchange of data between different actors in the transport system meaning that supply and demand can be matched in real time. It is a key objective of the Department of Transport, Tourism and Sport (DTTAS) to develop strategies and policies that take account of future developments in the Transport sector, including Intelligent Transport Systems (ITS). The development of a National ITS Strategy for Ireland is being progressed and is being developed in alignment with the work of the European Commission's Road Map for Europe on Cooperative Intelligent Transport Systems.

The use of ride hailing apps, car share platforms and the adoption of driverless vehicles will also transform transportation. The EU is pursuing a strategy of introducing connected and autonomous driving in stages. Some of the necessary infrastructural developments for this are already being progressed in Ireland, such as digital road mapping. DTTAS are continuing their engagement with relevant stakeholders in the area.

8.1.4 Public Administration, Education and Healthcare

Up to 17% of the public sector workforce are at high to medium risk of being impacted from the adoption of digital technologies. The public sector includes a higher number of roles in areas that are associated with administrative activities, consisting of repetitive and predictable tasks, and therefore are ripe for automation using RPA technologies. The public sector has already started adopting these technologies in government agencies such as Revenue, the Public Appointments Service, the Office of the Refugee Applications Commissioner and the National Shared Services Office. However, the sector also includes occupations where people are required to engage in a high level of personal interaction, such as teachers, medical practitioners, or practitioners in social services, all of whom will face significantly less risk. It is important to note that many roles will require increasing levels of social and cognitive skills as retained staff take on more complex, judgement-based tasks that are beyond the capability of today's technologies.

8.2 Cross-Sectoral Impacts from the Adoption of Digital Technologies on Ireland's Workforce

The adoption of digital technologies will have varying impacts across regions and age groups and will cut across sectors. This will require a holistic approach from Government in addressing issues such as regional vulnerability and the implications of the changing demographic of the Irish workforce.

8.2.1 Productivity and Inequality

Improving productivity is the key foundation of sustainable, longer term wealth creation. Increased output per hour worked allows firms to increase wages in a manner that will not damage their long-term viability. Improving productivity, based on better trained and educated workers, is a core objective of Enterprise 2025 Renewed, Ireland's enterprise strategy. The rapid adoption of digital technologies can also help drive higher productivity, thereby increasing aggregate wealth levels in a sustainable manner.

However, without active intervention there is a risk that positive returns from increased digitalisation will flow mostly to the most productive workers and the owners of the most successful businesses, thereby increasing market income inequality across society. Rather than allowing the social protection systems to carry the potentially growing burden of redistribution it may be more efficient and equitable to invest continually in upskilling the low-skilled, whether they are employed or unemployed.

8.2.2 Regional Impacts

The regions most at risk are that of the Midlands (where 5% of the workforce are at high risk and 64% are at medium risk) and the Border region (where 5% of the workforce are at high risk and 62% are medium risk). The fact that the Border and Midlands are the regions at highest risk is particularly challenging since these are also among the regions most likely to be impacted by Brexit. In addition, unemployment is already higher than average in these two regions. By contrast, just 2% of the workforce employed in Dublin are at high risk, mainly in sectors such as Retail and Hospitality.

8.2.3 Fuller Working Lives

There is no statutory mandatory retirement age for the majority of workers, though employers can fix retirement ages if they can objectively justify doing so. The age of entitlement for the State pension is currently 66 but will rise to 67 in 2021 and to 68 in 2028. This will lead to a position where a person might be obliged to retire at age 65 but must apply for a means-tested employment benefit for three years before they are entitled to a State pension. While the impact from this change is unlikely to make any difference over the course of the five-year forecast, this could have consequences both for industry and government over a longer term. Changes to the State pension age coupled with changes in migration patterns and the increasing cost of living could cause the number of older workers participating in the labour market to continue to rise.

As fuller working lives become more prevalent, there will be a need to engage and retrain workers to reduce the impact on the economy and the welfare state. It will be vital that workers at all stages of their working lives continue to upskill and reskill as roles become more digitalised. The Government is already supporting enterprises and workers in this area through programmes such as Springboard+, which offers courses to people who are already in employment and looking to retrain, and the recently launched EXPLORE programme, which aims to improve the digital skills of workers. It is important to build on this work to support fuller working lives across sectors.

8.3 Ensuring the Best Outcomes from the Adoption of Digital Technologies in Ireland

Ireland has already started to address the challenges digital technologies could bring. Navigating a successful path for both enterprises and workers will depend in no small part on the ability of all parties to come together to address these challenges. This will require the combination of support for technology areas which enterprises are adopting and training to provide workers with the skills to manage change.

Ireland needs to go beyond the traditional approaches of more widespread broadband connectivity, improved IT literacy, increased e-commerce and better electronic services from public administrations that are the staple of government ICT and Industry 4.0 strategies. To prepare for the change that is coming Governments will need to act on both an in-depth and broad basis moving forward.

There are five key areas that should be focused on:

1. **Vision.** The Government needs to set clear and communicable goals. These should cover common enablers that are necessary to ensure a sound infrastructure is available for enterprises to build on. This needs to be supported by regulations that allow enterprises to make the most of the data that is collected via interactions with end users and through the increasing number of connected devices that comprise the Internet of Things. It should set the framework for the sectors, academia and civil society to channel their innovative ideas.

   The Action Plan for Jobs 2018 committed to the completion of a framework for the development of a National Digital Strategy that would provide a coherent vision across sectoral policies to position Ireland to maximise economic and societal benefits from digitalisation. This action is being undertaken as a shared project led by the Department of An Taoiseach, the Department of Business, Enterprise and Innovation, the Department of Communications, Climate Action and Environment, and the Office of the Government Chief Information Officer. The framework, informed by input from roundtable discussions with key stakeholders was agreed by Government in July 2018. The framework consists of six pillars which are access/supporting infrastructure, trust and use/widespread adoption, society and well-being, enterprise and innovation, labour market and digital government. A public consultation will further inform the strategy. The publication of the strategy is expected in Q1 2019.

2. **Collaboration.** Performance management and other governance processes should allow for collaboration across government departments and with the broader ecosystem. This can be achieved by applying what the European Union calls the Quadruple Helix model, in which the main protagonists of innovation-generating processes (industry, academia, government and civil society) collaborate to accelerate the transfer of research and innovation results to growth. It is evident that this sort of collaboration is underway in some areas already. The aforementioned SmartAgriHub project in which Waterford Institute of Technology is playing an important role project is a positive example of sectoral collaboration.

   The area of R&D provides further strong examples of cross-sectoral collaboration between industry, academia and Government. This has resulted in a host of different R&D supports, such as EI Innovation Partnerships, EI Technology Gateways, EI Technology Centres, Science Foundation Ireland (SFI) Research Centres, SFI Industry Fellowships, SFI Strategic Partnership Scheme, Irish Research Council's (IRC) Enterprise Partnership Scheme and the Intertrade Ireland FUSION program. This suite of R&D programmes supports foster collaboration between enterprises, researchers and academic institutions. Enterprise Ireland currently has 14 industry-led research centres in their Technology Centres programme and a further 15 centres of R&D excellence in its Technology Gateways Network. SFI have established 16 research areas across varying thematic areas aimed at potentially having a major economic or societal impact on Ireland.

   The collaboration in the R&D area provides an exemplar of how Government, academia and industry can work together successfully to maximise mutual benefits. It highlights an opportunity for further collaboration across the economy both on a sectoral basis and more broadly. With disruptive technologies coming increasingly to the fore, cross-societal collaboration could help to identify necessary steps required to reap the fullest reward from the adoption of digital technologies.

3. **Data.** Information is becoming increasingly important to enterprises. The growing volume, variety and velocity of data drives demand for appropriate storage, archiving and management, so that they are accessible on demand for analysis and delivery to multiple devices. People, processes and physical assets will have an increasingly richer digital twin. This will drive demand for security tools that can protect data to ensure continuity, integrity and resilience without stifling data sharing and analysis. In addition to data quantity and data variety, the issues of data quality (i.e. the need to have valuable and reliable information), data accessibility (i.e. collecting and integrating the necessary data from all possible sources), effective data usage (i.e. how to best use the data), data bias (i.e. arising from biased algorithms), data ownership and governance, evaluation and monetisation appear to be some of the most pressing challenges to be solved today. Government agencies are doing much to stimulate this area through public sector data and established vendors and innovation funding, and should continue to focus on working with industry to identify cases where data can help drive business development.

   In the case of the public sector, the need for a National Data Infrastructure, incorporating

permanent unique identifiers and common data standards, is outlined in the National Statistics Board's Strategic Priorities for Official Statistics 2015 – 2020.[21] Work in this area is ongoing. In response to the potential for data to help deliver economic, social and democratic benefits, the Open Data Portal was launched to make data held by public bodies available and easily accessible online for reuse and redistribution. The portal is operated by the Government Reform Unit of the Department of Public Expenditure and Reform. The Data Sharing and Governance Bill, published on 12 June 2018, provides a legal basis for the sharing of data between public bodies while also setting out appropriate safeguards under which such sharing should take place.

4. **Technology**. The increasing number and variety of connected devices and technologies means enterprises know more about their environment than ever before. Making sense of the data generated by new technologies and being able to act on it will be what separates the digitally successful enterprises from those that are not. The ability to react to changes will come from how enterprises value and interpret the data environment around them. Technologies such as IoT, big data, machine learning, and AI can all be combined to form a continually sensing and learning environment. To be successful in this new environment, enterprises will need to derive meaningful insight that can be actioned for efficient, personalised services, improved industrial processes, product innovation and financial performance. Large and diverse data sets can create challenges for any organisation, but when combined with innovative technologies they can be used to create new business opportunities and revenues and improve public services.

   Whilst it is important that Ireland improves its core technology capabilities, there should also be a focus on the more disruptive innovations coming through. The National Development Plan under Project Ireland 2040 confirmed the establishment of a €500 million Disruptive Technologies Innovation Fund (DTIF). This is a competitive fund implemented through the Department of Business, Enterprise and Innovation and its agencies over a ten-year period. The aims of the fund are to: support enterprises to exploit the opportunities associated with disruptive technologies; encourage collaboration between enterprises and with the public research system; build on existing research in Ireland and leverage that research for commercial impact; and prepare Irish enterprise and public bodies to engage in European and global partnerships in deployment and development of disruptive technologies. A first call for expressions of interest was issued with a deadline of August 2018. Over 300 applications were received. The applications received involved a high degree of collaboration with many bids for funding involving multiple partners. The high volume of applications indicates that there is significant interest for projects seeking to develop and deploy disruptive technologies in Ireland. Successful applicants for this fund will be announced by the end of 2018. There will be further calls for funding under DTIF, including in 2019.

5. **Skills.** Enterprises across different sectors have recognised that to be successful in their adoption of digital technologies they need a different set of skills. Governments globally

[21] Available from: http://www.nsb.ie/media/nsbie/pdfdocs/NSB_Strategy_2015-2020.pdf

recognise the need to work with employers and education providers to invest in educational outcomes that support the jobs of tomorrow.

Firstly, it will be important that the right technical skills are available to enable the adoption of digital technologies. The Government has prioritised the promotion and development of high-level ICT skills. In 2013 the EGFSN completed a study on 'Addressing Future Demand for High-level ICT Skills'. The study included a demand forecast for such skills, both in the ICT sector and across other sectors of the economy, over the period 2013-2018. A related objective was how Ireland could retain and attract high-level ICT skills to address high-level ICT skills recruitment needs. The findings and recommendations of the report were essential inputs into the development of the 'ICT Skills Action Plan 2014-2018'. In early 2018, the EGFSN engaged in a refresh of the demand forecast exercise for ICT skills for the period 2017-2022. This analysis was a key input into the upcoming ICT Skills Action Plan which is expected to be published by the Department of Education and Skills (DES) before the end of 2018.

DES is also supporting the development of digital skills in primary and post-primary schools through the 'Digital Strategy for Schools 2015-2020'. The strategy sets out a clear vision focused on realising the potential of digital technologies to transform the learning experience of students by helping them to become engaged thinkers, active learners, knowledge constructors and global citizens. The strategy emphasises the importance of embedding ICT in education systems and ensuring there is a modern curriculum that enables digital learning. This strategy will result in increasing digital literacy amongst school going children.

IT literacy should be part of a broader change management and training programmes that enable new graduates joining the workforce and more senior people to embark on a continuous learning path that will allow them to understand the business implications of digital transformation. Training programmes should be aligned with the overall strategic goals of the digital agenda. Data-driven decision-making is a core skill that should be developed.

Incentives for enterprises to invest in retraining and reskilling are strong across Ireland (e.g. Apprenticeships and Traineeships; Springboard+, Skillnet Ireland and SOLAS' Skills to Advance campaign). However, even when there is a clear need to invest, enterprises face significant barriers. These barriers include cost, wage demands, time gaps between investment and return, difficulty in releasing staff to focus on training or reskilling, slowing investment and ultimately costing them competitive performance. While existing programmes such as those mentioned here are helping to incentivise training in specific technologies, overcoming these hurdles requires closer coordination and collaboration across sectors.

Adopting digital technologies is not just about technical IT skills. Ensuring that enterprises are equipped with staff with the right soft skills will be vital to the success of the adoption of technologies. A clear knowledge of business and operational challenges is required, because unlike the automation of manual processes and machines, the implementation of digital technologies is proactive rather than reactive. Digital technologies enable enterprises to drive innovation towards new products, new markets, new industries and better customer

interactions. Soft skills such as interpersonal communication, change management and strategic thinking are just as important.

The successful implementation of digital technologies will hinge on the workforce's soft skills. The importance of soft skills has been highlighted in the National Skills Strategy 2025. The strategy identified that soft skills are becoming increasingly important to an individual's successful and sustainable employment and enable participation in lifelong education and training. As such, the strategy placed an emphasis on the development of soft skills at all levels of the education system.

In light of the findings of this EGFSN report, the following soft skills have been identified as being of particular importance:

- **Leadership skills.** The adoption of technology is often preceded by innovative thinking on how technology can be used to improve processes and business activities. This requires an understanding of, and an empathy for, the challenges and opportunities facing business and workers. Skills such as emotional intelligence and strategic thinking will be important to help guide organisations when making decisions.
- **Interpersonal skills.** Navigating change requires a diverse set of skills, from change management and content presentation to facilitation and conflict resolution. Implementing technology can often be much easier than getting people to transition to new processes. Adopting digital technologies entails change, and in turn this can cause friction and tension. Unchecked, this can become unhealthy for organisations. Therefore, the ability to identify and address these issues before they become wider is key.
- **Business skills.** Having the technical skills to effectively manage digital-related projects is an obvious need. Less obvious are the skills needed to enhance project manager effectiveness, or the business analysis skills to understand new approaches to programme management such as design thinking and the ability then to influence stakeholders, business partners and those in other organisational silos.

8.4 Future Workstreams

As is clear when considering the five key areas mentioned above, Ireland is already moving in the right direction to prepare for and respond to the future demands resulting from the increased adoption of digital technologies. Each of the five key areas of Vision, Collaboration, Data, Technology and Skills are being addressed in different ways.

Table 7: Current Policies and Initiatives in Place Addressing Five Key Areas of Focus

Key Areas	Policies and Initiatives Addressing Areas
Vision	National Digital Strategy
Collaboration	R&D Technology Centres/Gateways Innovation Partnerships SFI Industry Fellowships
Data	National Data Infrastructure
Technology	Disruptive Technologies Innovation Fund Industry 4.0 Strategy
Skills	National Skills Strategy 2025 ICT Action Plan National Digital Strategy for Schools Skills for Growth Initiative Spotlight on Skills Skillnet Ireland Springboard+ EXPLORE

As displayed in Table 7, the existing policies and initiatives in place provide a solid foundation for response to the oncoming expected changes. Ireland currently has the opportunity to position itself at the forefront of digital technologies through ensuring adequate skills provision and capitalising on its significant ICT sector. An example of the kind of benefit that can be derived by early mover advantage is the new MSc in Artificial Intelligence being offered in the University of Limerick. Developed in 2018, this MSc is helping to place Ireland as a leader in the digital revolution as it is the world's first industry-driven nationwide MSc in AI. Additional similar initiatives to increase AI specialists and to capitalise on the benefits of digital technology adoption could be pursued to further place Ireland at the helm of the digital economy.

It is clear that occupational change is already taking place in the structure of the Irish economy. The challenge that lies ahead is creating an understanding of what skills gaps are likely to emerge, the quantity and nature of these skills gaps, and how the Government addresses them. Both the Department of Business, Enterprise and Innovation and the Department of Education and Skills, and their agencies, have roles to play to ensure that the opportunities arising from the adoption of digital technologies can be maximised and the negative effects minimised.

The Department of Business, Enterprise and Innovation, through its agencies of EI, IDA and SFI must facilitate enterprises to be in a position to take advantage of the opportunities emerging from the adoption of digital technologies. To be successful, enterprises will need to understand how to use new technology to improve productivity and how to use new data sets to their full advantage. EI and IDA have a role to play in ensuring that enterprises both understand and are prepared for this. Enterprises should be encouraged to review their businesses to ensure that they are ready for skills

deficits that may arise in the future. Initiatives such the Enterprise Ireland Spotlight on Skills workshops which feed into the Department of Education and Skills' Skills for Growth Initiative are key to this kind of planning in getting enterprises to develop company skills plans.

The Department of Education and Skills is already responding to skills challenges as is evident by its many strategies and frameworks. It is evident that there are a number of different routes available to individuals for upskilling and reskilling opportunities. However, it is important to take into consideration that the adoption of digital technologies will require different responses for different cohorts. There are many individuals who will take advantage of reskilling and upskilling opportunities and will be able to upskill into roles that complement new technologies. However, there is also the potential that some individuals will not be capable of upskilling to work in new roles. With this in mind, it is vital that our skills architecture can be responsive on an individual level to ensure that there are pathways back into employment for those facing redundancy. In order for the system to be ready for this, the Department of Education and Skills and its bodies should consider the current actions in place in relevant policies and strategy documents to ensure that they can be targeted and tailored at those facing redundancies as a result of the increased adoption of digital technologies.

It is evident that the national enterprise strategies, and the skills architecture that underpin them, provide a strong infrastructure under which the challenges of the future can be addressed. Whilst it is apparent that systems are functioning well in respect to our current economic climate, it is important to ensure they can deal with the ongoing future challenges arising from the increased adoption of digital technologies. It is crucial that the systems in place can both deal with the scale of the challenge ahead and have the capacity to respond to the challenges in a timely and effective manner.

In the future, the use of new digital technologies will be increasingly prevalent throughout society. Currently, it appears that Ireland is at the early stages of digital technology adoption. Over the next decade, the impacts of the increased adoption of digital technologies will become more pronounced. This provides the Government with an opportunity to monitor the effectiveness of existing systems as they respond to the impacts on the workforce from the increased adoption of digital technologies. In doing so, the Government can ensure that existing systems and policies are scaled up and ambitious enough for the time when the greatest impacts will be felt. It is crucial the Government can intensify existing measures if so required.

Appendix 1: Case Studies

The following case studies describe how organisations adopted digital technologies to derive benefits including improved efficiency, greater productivity, cost reduction and improved customer engagement.

Air21

Air21 is a logistics, transportation and warehousing firm based in the Philippines whose mission is to provide reliable and innovative logistics services, driven by customer insights. Air21 saw that digital technologies in the logistics industry had allowed their international counterparts to improve their efficiency in shipment deliveries. A high number of delivery service failures can lead to additional expenditures, especially with the inefficient use of capital resources. This global trend had brought forth daily delivery success rates as high as 95%, while non-adaptive logistics companies would only average a 75% delivery rate. This inspired Air21 to begin their digital transformation in 2013.

Challenge

Managing over 25,000 clients and 70,000 airway bills each day across the Philippines, Air21 saw how they could benefit from adopting digital technologies in their operations. Working with an external IT supplier, Air21 began their digital transformation journey with an automated shipment tracking and business analytics system, the first local logistics company to implement such a system. They then launched their 'Command Centre' to monitor operations nationwide, analysing gathered data to support enterprise-wide operational transformation. Among the key aims and objectives were to address the challenges of delayed deliveries, the manual system of reporting delivery status and the requirement for signed invoices to be received before billing could occur.

Implementation of the Command Centre began in 2014 and it was fully functional in 2016. It involved investment in a range of technologies centred on an Enterprise Private Cloud infrastructure. To gain a complete view of the entire delivery cycle, the company gathers data the moment it receives packages from its clients. Operating on a hub-and-spoke model, all stages of the delivery are monitored from the warehouse all the way to the final destination.

The company's goal is to achieve a minimum delivery rate of 95% daily. With the Command Centre providing visibility of the entire operation, it can detect issues that may arise from the field and address them immediately. Using historical data, it sets parameters for delivery performance that will allow the operations specialists to detect anomalies in the field, something they call "predictive proof of delivery" This historical data allows the company to determine the percentage of successful deliveries at any given time and area all over the country. Measurements can be further refined as more data is gathered, which allows the operations team to make informed decisions when it comes to route planning and the deployment of additional manpower to remedy service failures in a particular area.

Outcome

As a result of the investment in their digital transformation initiative Air21 has achieved major improvements in productivity and business efficiency. Manual report generation has been eliminated and the monitoring of delivery status has been improved dramatically, as has the ability for early identification of breaches in pickup and delivery.

In addition, the company has been able to mine its new data warehouse to track deliveries to consignees, many of whom have been identified as small businesses, and to offer delivery services to these companies too. It was also able to use data analytics to identity the best areas to build new hubs. Having identified hospitals as frequent consignees they elected to build a hub nearby. Overall Air21's on-time delivery performance increased from 75% to 95% while there has been an 83% fall in the requirement for overtime and a 12% reduction in manpower.

ANZ Bank

The Asia-Pacific region is leading the way in the adoption of Robotic Process Automation (RPA), and the Financial Services sector is at the forefront of this movement. It is no surprise, therefore, to find that ANZ, one of the top four banks in Australia, was an early adopter of RPA.

Challenge

ANZ Bank had two key objectives for embarking on the adoption of RPA. The first was to cut costs by automating repetitive labour-intensive tasks. The second was to improve efficiency, which would be seen particularly in greater accuracy in transactions, consequently making it easier to meet regulatory requirements.

RPA can be defined as a software code that automates and assigns standardised, rules-based, repetitive, and high-volume processes involving several interoperable systems — which were traditionally executed by humans — to a robot. To a certain extent, RPA can be described as human-defined decision-making, where rules are created by humans, with these rules determining the triggers, process flows, and activities to complete a business process. While process automation is not new, RPA does offer distinctly advanced features, including the potential of delivering meaningful customer support, improved decision-making and valuable customer insights when coalesced with cognitive technologies.

A broad evaluation of deployments by early adopters of RPA in Asia/Pacific financial institutions has shown the following typical outcomes:

- Financial services institutions can achieve cost savings in the range of 30%–60%. However, actual numbers would ultimately vary based on the cost base, the market, the business process itself, the investments needed to support RPA, and so forth.

- The implementation time required is also short, usually ranging from 6 to 12 weeks. Technology buyers can recover their initial RPA investment ("break even") within anything from ten months to two years.
- With RPA, the turnaround time to complete a process can decrease significantly. Early indicators point to a reduction of turnaround time by 50%–90%.

Outcome

Two years after kickstarting its automation journey, ANZ Bank has now deployed 2,000 robots, reduced costs by 30%, and increased accuracy to almost 100%. In addition to improved cost savings and accuracy rates, the bank has also shortened the time spent on complex processes by up to 50% and avoided 34 regulatory breaches. The bank has plans to deploy 12,000 bots across its shared service centres by the end of 2018.

Health Regulatory Body

For well over a decade, organisations have been looking to print and document management initiatives as a way to reduce costs, increase employee productivity and better meet security, regulatory/compliance and environmental/sustainability goals. During that same period, content delivery has seen a shift from paper to electronic format. As companies continue down the path of digital transformation, 3rd Platform technologies provide organisations with a foundation to fundamentally change document-intensive workflows for better business outcomes.

Challenge

A large US provider of healthcare regulatory services acquired another business as part of its ongoing operational strategy. The new company's claims reimbursement process was inefficient. Claims were processed manually and on a quarterly basis, and the company would often hire temporary personnel each quarter just to handle manual data entry for the backlog of claims. The entire process was time-consuming, costly and susceptible to human error. It was immediately clear that a new workflow process was needed to automate and speed up the processing of claims. This prompted the parent company to partner with an external services provider and streamline this process, resulting in significant time savings and cost benefits.

The services provider recommended a forms automation and intelligent data capture solution. This would allow the company to capture documents on demand or in a batch directly from scanners and MFPs and intelligently extract the appropriate information from identified fields within the document using OCR technology. Using forms automation, data could be extracted into a CSV file and imported directly into the appropriate database with little to no manual intervention required. The solution is also leveraged to create intelligent forms with embedded logic to integrate data with the company's various internal systems.

Change management proved to be one of the more significant hurdles to overcome with the new implementation. The newly acquired company was resistant to change and trust had to be gained in the new solution.

The scope of the overall project turned out to be larger than originally anticipated. Initially, it was determined that approximately 30 forms needed to be created. However, once the process was under way, it was discovered that there were various intricacies associated with each form, and the number of new forms grew to approximately 300.

Outcome

As a result of deploying the forms automation solution, the organisation has realised significant improvements in business process efficiencies, reduction in overhead costs, and decreased time to process payments. In fact, cost savings were seen even in the very first processing cycle. The need to outsource data entry tasks has virtually been eliminated, and the company has reduced its outsourcing requirements from ten temporary workers down to just two.

In addition, the time taken to process claims has been reduced from as long as ten weeks to just three weeks, helping alleviate concerns over not meeting payment deadlines. The organisation has also seen a substantial decrease in human error. Overall, both the service provider and its acquired company agree that the solution has helped tremendously to improve productivity by streamlining the claims processing workflow.

Malaysian Entertainment and Hospitality Group

In 2015, a market-leading Malaysian company operating in the Entertainment and Hospitality sector could see the shifting dynamics in the Hospitality sector in Asia — competitors in China and Singapore were using digital technologies to reach a wider audience and create more seamless customer experience (CX), and attracting a younger, more digital-savvy demographic. The company knew that it had to adopt a digital strategy to reach its customer base through more online channels and create a brand that would be more appealing to a younger audience.

Challenge

The company realised that it needed to increase and improve its social media presence before it could focus on its other digital marketing challenges. The following were the roadblocks identified:

- Lack of awareness on social media. Back in 2015, the company had about 200,000 Facebook fans, but posts would only reach about 100 or 200 people.
- Inconsistent tone and messaging. Different departments used varying tones and messaging on social media.

- Lack of understanding on performance metrics of digital/social marketing. Strong need for members of senior management and heads of lines of business (LoBs) to be educated about its benefits and how results can be measured.
- The company also had a primitive email marketing platform, a poor website and a lack of customer service centre bandwidth. Marketing channels were not integrated either. Its CRM software was not integrated with its email marketing platform, making it difficult to track customers who availed themselves of promos through marketing campaigns and personalise communications to customers.

A major cultural and mindset shift was needed for the company to deliver a new customer experience vision. A key goal was to identify an underlying theme among all business units and align it with the company's overall vision to become a world leader in its sector. A new approach was taken to social media, one which applied basic marketing principles. Customers needed to be reminded what the company was.

Early digital campaigns used funny, light content and engagements started to increase. With social media, content must go hand in hand with customer interaction. As customers rely more on their online experiences as they make their decisions, companies need to not just increase their presence on social media but also ensure consistent communication and interaction with their customers.

As the company's social media reach improved through an improved content strategy, the digital team also began to plan its database marketing strategy. The CRM software was integrated with the marketing automation software. The company launched its first automation project, a simple one involving SMS and then email. A reminder email was sent after 24 hours to those who didn't avail themselves of a promo via SMS with a further one seven days later.

Aside from targeted advertising, the company also wanted to learn more about its customers' preferences and sentiments online. Using the same marketing automation platform, it set up a listening tool to learn about its customers which would become a centralised source of data from social media, blogs, travel site aggregators and online reviews.

Outcome

Previously, the company's customers found their engagements with the company to be passive, inconsistent and fragmented. For the digitally engaged audiences, these resulted in brand apathy, loss of attention and missed opportunities to deepen customer understanding. Maintaining mindshare and staying top of mind became a priority for the firm. This was made possible by improved use of social media and customer engagement. These improvements allowed the company to improve its customer sentiment score which changed from 25% of customers measured as "happy" in 2016 to 75% by mid-2017.

Website visits also increased from 100,000 to 500,000 after its first marketing automation project. Initially, the company's website and customer service call-centre were unable to keep up with the

upsurge in visits and call volume. The digital team took this situation as further proof to convince senior management to increase investments in technology and enhance the organisation's central customer information systems. Finally, improving social media reach and engagement, data-driven marketing, and targeted advertising increased its year-over-year bookings by 69%, from the period of January- August 2016, to January- August 2017.

Appendix 2: Review of International Approaches to Upskilling

Concerns expressed in recent years about the potentially negative impacts of digitalisation/automation on workers have led stakeholders, including governments, businesses and various organisations to explore ways of addressing this challenge. Their aim is to ensure that people whose jobs are in danger of being automated are provided with new skills, so they can either adapt to changes in their current job role or, in the event of redundancy, find a different job.

However, the EU highlighted the extent of the challenge in a recent report. It stated that "the resistance to adopt new technologies and to change tasks or functions is alarmingly high amongst the workforce in Europe". While the application of retraining and upskilling programmes driven by the threat of automation is not widespread, a number of initiatives are worthy of note.

Country-Specific Programmes

Singapore

In recent years, Singapore has implemented a support programme aimed at helping people to upskill. The "SkillsFuture" initiative began in early 2016 and had the objective of improving growth and competitiveness across a range of industries. The Government provides all over-25s with a credit equivalent to around $400 to fund training courses. Thousands of courses are available, and by the end of 2016 McKinsey reports that more than 120,000 people (around 4% of the population aged 25 or over) had used the programme to take training courses, with more than half of them aged 40 or over.

Brazil

In Brazil, the Brazilian Fund for the Protection of Workers (FAT) provides resources for vocational training. Three of the main trades unions have responsibility for providing vocational training courses at the national level as well as through regional affiliates. There is a particular focus on the Tourism and Hospitality sectors. These programmes cater to both employed and unemployed workers looking to work in diverse segments of the Tourism and Hospitality supply chains. Coursework includes hygiene and food handling, information technology, hospitality management and motorboat maintenance.

South Korea

South Korea has an education programme which, while not aimed at upskilling existing workers, has been successful in ensuring that young workers have the skills they need for employment. Though the country has a high rate of university enrolment, it found that unemployment rates for graduates were also high. The Government examined apprenticeship systems in other countries (notably Germany and Switzerland) and transformed some of its vocational schools into "Meister" schools. By 2015 there were 40 of these. By the time students graduate, they have gained two years' work

and/or community college experience. Though the scheme is still in its relative infancy, the Meister schools have achieved employment rates for its graduates of over 90%. The Ministry of Education reports that there has also been an increase in admissions to vocational training at the expense of college applications as a result.

Denmark

In Denmark, stakeholders including employers, trades unions and the Government work to maintain the country's "flexicurity system", which offers active job counselling, career guidance, training or education to all unemployed individuals while all workers have access to vocational training programmes. The aim is to have a labour market characterised by flexible employment and job security. The stakeholders get together to identify skills needs and agree on wages and rights to paid training leave.

United States

The UpSkill America initiative, launched in 2015, specifies that states should allocate budget to the development of existing frontline workers. Measures included expanding on-the-job training, increasing employer-provided education benefits to help employees attain a higher qualification while working, and partnerships between education providers and technology innovators to promote technology-enabled learning.

Employer-Led Programmes

AT&T

AT&T identified that changes in the telecoms sector such as the rise of cloud computing would require it to have workers with new skills. The company decided to address these changing needs by reskilling its existing workforce. AT&T adopted the WF2020 program, which began to incentivise workers to do training and linked learning to performance reviews. Roles in the company were restructured and standardised to increase job mobility and interchangeability of skills. Financial support was provided for acquiring new skills.

AT&T partnered with Georgia Tech so that employees could enrol in the university's online computer science program, which AT&T helped to set up. AT&T's internal projections suggested that 95% of the 135,000 employees in its technology and services unit would need training in STEM (Science, Technology, Engineering and Mathematics) subjects whereas only 50% had such training in 2013. The company has invested $250 million on employee education and development in the first few years of the programme. As a result, 140,000 employees have been engaged in acquiring skills for new roles. Training performance is also a consideration for advancement, with many management jobs being taken up by those who have participated in retraining.

ManpowerGroup

ManpowerGroup is helping redundant workers in France transition to new careers by developing their skills for sectors where there is demand such as IT and call centres. Through FuturSkill, the organisation delivers four month-long programmes including skills assessments, training and access to online learning systems in both hard and soft skills for people across France. ManpowerGroup's Bridge-To-Work programme seeks to match unemployed people to in-demand positions. According to the World Economic Forum, Bridge-To-Work has placed 90% of its candidates into diverse roles such as IT help desk technicians, developers, customer service representatives and production workers. This represents double the placement rate of publicly funded programmes in France that do not link training to direct employment opportunities. The company also operates similar initiatives in other countries, including China and India.

Cognizant

Cognizant is one of the largest technology employers in the US and plans to grow its workforce by at least an additional 25,000 over the next five years. In a recent development, Cognizant announced in early 2018 the formation of a new non-profit foundation to support STEM (Science, Technology, Engineering and Maths) and digital education and skills initiatives for US workers and students. The foundation will be established with an initial grant of $100 million.

The new foundation will focus on funding education and skills programmes in multiple cities and states to help improve opportunities for US workers and students. The company reports that, according to the US Bureau of Labour Statistics, by 2020 there will be a 1.4 million person gap between software development jobs and qualified applicants to fill these positions in the US.

International Policy

Concerns about potential job losses as a result of digitalisation/automation have led governments and organisations around the world to focus attention on this area. The EU, OECD and World Economic Forum are among the organisations to have published material on how best to address the challenge. In this section we will discuss some of the policy documents that have been produced.

In 2016, the European Commission published "A New Skills Agenda for Europe: Working Together to Strengthen Human Capital, Employability and Competitiveness". This set out ten priority actions it proposed to undertake to improve the situation in the EU, with regard to skills availability, while calling on member states to implement policies along similar lines. Among the areas covered were the importance of basic skills including numeracy and literacy as well as more complex skills.

Digital skills were also identified as an area where improvement was needed. The need for greater transparency and comparability of qualifications across borders was also recognised. Improving intelligence on skills requirements so that better career choices can be made and the need for greater cooperation between sectors of the economy were also emphasised.

To address the outlined issues, the measures that needed to be undertaken included greater opportunity for work-based learning and business education, and greater opportunities for workers to validate non-formal and informal learning. The need to modernise education and learning was also recognised, including the need for greater support for teachers and trainers and the modernisation of higher education. One of the chief goals of the New Skills Agenda "is to raise political awareness of the critical importance of skills for Europe's jobs and growth prospects, and to address this issue at the highest political level". Many countries, including Ireland, have followed with policy implementations of their own.

In the USA, the Upskill policy of 2015 was focused on "realising the full potential of America's workforce by empowering Americans with the education and training they need to develop new skills and earn higher wages". This was primarily aimed at those on low wages or with low skills. It recognised that low-wage earners were less likely to be offered training by their employers than those on higher wages. The policy sought to encourage employers to provide training to their workers and to provide examples of businesses that had implemented such training programmes effectively.

The World Economic Forum published its report, "Accelerating Workforce Reskilling for the Fourth Industrial Revolution: An Agenda for Leaders to Shape the Future of Education, Gender and Work", in July 2017. It outlined several "Key Pathways to Change" that policy-makers should follow when addressing this area under headings which include but are not limited to:

- Taking stock of and recognising existing skills.
- Building and sustaining motivation for adult learning through active labour market policies and accessible resources.
- Recognising and promoting on-the-job training opportunities and maximising informal learning opportunities.
- Reaching those that need it most — SMEs, lower-skilled workers and older workers.

This report highlights the current changes in the demand for skills and, consequently, the extent of the changes that need to be made to address the challenge. One area of interest is the area of financing and the types of incentives used to promote retraining and upskilling. Many methods have been used around the world, including payroll taxes dedicated to subsidising training opportunities, income tax deductions for businesses, a "fine" to be paid if a minimum amount is not allocated to training, as well as direct grants for subsidising training in SMEs.

The importance of incentivising individuals to participate in training is a point of emphasis. Measures include subsidised vouchers and training funds for individuals, tax deductions and loans. The WEF reports that tax deductions have been found to be effective in encouraging participation in adult training in the Netherlands. In Singapore, a two-pronged approach is used, with subsidies for the provision of training by suppliers and credit in the training accounts of individuals to encourage demand.

Appendix 3: Project Scope and Methodology

Scope

The aim of this study was to assess the impact of digitalisation on job roles and sectors across the economy in Ireland and to identify potential enterprise and skills policy actions that could address the effects on the workforce. The study was to take a medium-term view of five years.

Methodology

IDC, in consultation with the Department of Business, Enterprise and Innovation (DBEI), used the following five-step approach to gather the information and develop the forecast, scenarios and recommendations needed for this study:

1. A quantitative analysis of the occupational and sectoral structure of the Irish economy and creation of an occupation/industry sector matrix of the workforce using a variety of CSO and other data provided by the DBEI.
2. A comprehensive desk research programme to identify research conducted which explores the impact of the various elements of digitalisation and how they will influence new job creation and skill demands in different sectors of the Irish labour market.
3. Application of this research to the matrix to provide a quantitative view of the potential job losses/gains because of digitalisation.
4. Interviews with fifteen enterprises and key informants in Ireland.
5. Input and guidance from the project steering group and five formal interviews with representatives of stakeholder organisation on policy actions.

IDC also drew on its own research to provide valuable insights, through IDC's Assumption Builder (a tool used to collect and assemble the foresight assumptions by the worldwide analyst body) and the main global economic and market forecast assumptions updated quarterly and circulated by IDC's central research unit. In addition, through the Innovation Accelerators research practices, IDC has a strong body of research and knowledge on the adoption of artificial intelligence and automation technologies that was used to provide further input to the project findings.

Risk of Automation

The economic model for this study was based upon four seminal reports conducted on digitalisation and/or automation. The studies are as follows:

- 'The Future of Employment: How Susceptible are Jobs to Computerisation?' Frey and Osbourne, 2013
- 'The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis' OECD, 2016
- 'Will Robots Really Steal Our Jobs? An International Analysis of the Potential Long-Term Impact of Automation' PwC, 2017
- 'Workforce Transitions in a Time of Automation' McKinsey Global Institute, 2017

The model has taken a mean of these forecasts to understand the probability of automation by NACE code. The overall impact of digitalisation differs in each model ranging from a loss of 25,000 jobs to 55,000 jobs by 2023. Using the mean of these estimates was deemed the most appropriate method of estimating the probability of automation.

Population

Total projected population for Ireland is used within the model according to CSO estimates from the 2016 Census. The working population is the total number of people aged between 15 and 65 that are available to work. It is assumed that the labour force grows in line with population growth.

Approach to Calculating GNI* by NACE

Modified Gross National Income (GNI*) for Ireland is calculated from official figures from the Department of Finance. GNI* more accurately reflects the income standards of Irish residents than GDP. It differs from GNI in that it excludes, among other things, the depreciation of foreign-owned, but Irish-resident, capital assets (most notably intellectual property and assets associated with aircraft leasing) and the undistributed profits of firms that have re-domiciled to Ireland.[22] GNI* is used in the model as a measure of national income.

Total GNI* value projections made by the Department of Finance from 2018 to 2021 are used as a proxy for the total economy in the model.[23] GNI* for the years 2022 and 2023 are calculated using a linear projection in the previous 5 years as the model assumes that GNI* growth is linear based on previous years trends. Sectoral projections are not available for GNI* but are available for GDP. Sectoral proportions of the GNI* projections are estimated based on the change trend in sectoral proportions of GDP between 2011 and 2014.[24]

Calculating Total Employment before Digitalisation

Total employment before digitalisation is estimated forward to 2023 by calculating the required employment to fulfil GNI* projections. This is done estimating the number of hours of labour required to produce Department of Finance GNI* projections, while taking account of changes in output per hour worked, based on recent trends. These projections are almost identical to current Department of Finance projections for total employment in 2023.

Education Levels for NACE

Total employment before digitalisation by education level and sector between 2017-2023 is calculated using a logest model forecast based on educational levels and population growth in 2011-

[22] Department of Finance, Draft Stability Programme Update 2018, available from: https://www.finance.gov.ie/wp-content/uploads/2018/04/20180417-SPU-2018-for-website.pdf
[23] Department of Finance, Budget 2019, Economic and Fiscal Outlook, available from: http://www.budget.gov.ie/Budgets/2019/Documents/Budget_2019_Economic_and_Fiscal_Outlook_F.pdf
[24] To remove volatility of 2015-2017 the data from 2011-2014 was projected forward to 2023. This was deemed as a more accurate reflection of the current economic trend and reduced the negativity associated with the 2015-2017 period.

2016. This was calculated to demonstrate the potential demand on different education and training systems for changes in each sector.

Regional Split

Total employment before digitalisation by region is calculated using the proportion of a region's sectoral employment to total employment in the latest available data (2018). No major demographic shifts in the population were assumed, so it has been assumed that historical trends will continue for at least the forecast period.

IT Investment

The projected level of ICT expenditure in each sector is assumed to be directly linked to the potential impact of digitalisation on sectors and the economy. The value for ICT expenditure has been sourced from IDC's Worldwide Blackbook data for 2nd and 3rd platform technologies and applied to IDC's Worldwide Semi-Annual IT Spending Guide on Industry and Company Size for Ireland. Not all expenditure on ICT will lead to jobs losses and is broken down into 2nd and 3rd platform expenditure.

2nd platform technologies are a basic form of ICT expenditure and does not change the final 'impact of digitalisation' figures. This could include expenditure on basic software packages. These are assumed to not lead to automation and job losses.

3rd platform technologies include cloud computing, mobile, big data and analytics, and social systems of engagement and integrated customer experiences that drive increased value. These have an effect on the impact of the digitalisation on total employment.

However, not all investment into 3rd platform technologies will lead to job losses. The underlying assumptions of the model include:

- Some of the investment into 3rd platform will be to replace the 2nd platform, but this does not mean that a job will be lost.
- Not all investment in the 3rd platform by year will be on new services, some will be on continuing services from previous years.
- However, if a job has been lost because of that spend in previous years it cannot be lost again. Only a proportion of the total spend on 3rd platforms can be taken as displacing a job in a particular year.

Probability of Automation by Occupation and Sector

The average probability of automation for each occupation in each sector is calculated using the average of four seminal studies, as mentioned above, by Frey and Osbourne, OECD, PwC, and McKinsey.

The impact of digitalisation on an occupation is calculated by multiplying the average probability of automation of each occupation by the growth in the 3rd platform expenditure less the growth in the 2nd platform expenditure adjusted for the probability of automation for the whole sector, to account for the assumptions in relation to ICT expenditure, as outlined above.

The impact of digitalisation on each occupation is multiplied by the total employment figure in each occupation to arrive at the total employment figure impacted by digitalisation. Total employment after digitalisation by occupation is subtracted from total employment before digitalisation by occupation to attain the impact of digitalisation.

Creation of New Jobs from the Adoption of Digital Technologies

The creation of new jobs arising from the adoption of digital technologies is not included separately in the model. The model projects the size of the future labour force by estimating the amount of labour required to produce future GNI* projections. This projection takes account of changes in output per hour worked based on past trends. Therefore, the forecast for the projected labour requirement, with no impact from digital technologies, contains some growth in jobs which is attributable to the past investments made in technology. This is dependent on the assumption that GNI* growth is partially being driven by sectors investing into technology to improve sales and operating margins, the development of extensions to existing services and products, as well as new ones which are derived from investment into technology.

Overview of Approach to Modelling Impact

Scope of Model — Inclusions and Exclusions

The economic model which has been produced as part of this project includes many different types of data from a range of sources as described in detail elsewhere is this report. What the model seeks to predict is very specific. Its aim is to estimate the extent to which digitalisation and automation will have an impact on the number of people employed in various jobs roles, sectors and regions of the country in the period 2018–2023. It provides two sets of data outputs:

- The number of people forecast to be employed without allowing for the impact of digitalisation and automation.
- The number of people forecast to be employed when the impact of digitalisation and automation are factored in.

This reflects the key aim of the research project, which is to assess the impact of digitalisation and automation on employment numbers in the period 2018–2023. The model does not seek to include the impact of other factors. IDC does, however, acknowledge that there are other factors that could have a positive or negative impact on the employment figures during this period. The following are some of the things that could happen that might influence the numbers.

The Multinational Sector

Foreign direct investment by multinational companies is a key component of the Irish economy, with over 210,000 people employed by firms that fall under the portfolio of IDA Ireland. Growth in this sector continues, with 20,000 additional jobs coming on stream in 2017, and the IDA has exceeded its job creation target for the sector in recent years. While there is little reason to see why growth in this sector won't continue, there is no doubt that any slowdown in economic growth at a global level could have a negative impact on job creation in this sector.

The US government has recently enacted legislation for a cut in corporation tax from 35% to 21%. This could act as a disincentive for US corporations to set up operations outside the country and particularly to base their intellectual property in other parts of the world for tax purposes. There is speculation that further legislation may follow in late 2018. The new tax laws have led to uncertainty, with the IDA reporting that decision-making in US businesses was slowing down as a result. However, there hasn't yet been any negative impact on the Irish multinational sector that can be attributed to these changes at this stage.

Trade Wars

The US Government has initiated a much-changed policy on international trade than had existed under previous administrations. Tariffs have been introduced on certain goods entering the US from China and the EU, making reference to major trade deficits between the US and these regions. Barriers to trade can reduce volumes, disrupt supply chains, increase prices and reduce economic growth. Given the prevalence of multinational firms with global supply chains in the country it is

possible that Ireland could feel a negative impact from this, particularly if further actions are taken by the US government. These could lead to reciprocal measures being taken by the EU and further escalations over time. This negative impact could be felt in terms of job losses.

Brexit

More than two years on from the Brexit vote there is no more clarity on what the final UK/EU deal might look like or indeed if a deal will be possible at all. Irish exporters already face an exchange rate challenge with sterling falling in value after the vote result was announced. However, the longer-term impact on the broader Irish economy is virtually impossible to assess, though it is clear that any disruption in UK/EU trade will have a big impact on Ireland. There have been positives for Ireland, notably in the fact that some organisations have moved, or announced plans to move, operations to Ireland from the UK as a way of staying in the EU. However, most evidence suggests that the potential downside for Ireland's economy as a result of Brexit would outweigh the positive benefits.

Infrastructural Challenges

Ireland's economy continues to grow, and unemployment has fallen to a very low level in 2018. This success has led to increased demand for housing, pressure on transport routes and similar challenges consistent with a growing workforce and population. While the Government is working to resolve these bottlenecks, there is potential for the situation to reduce Ireland's attractiveness to foreign investors and workers.

These are the primary issues that are identifiable now that could have an impact on the numbers employed in Ireland in the period 2017–2030. Clearly, other events may take place in the years to come that could also have an influence.

Appendix 4: Existing Skills Programmes

Skills Organisations

Skillnet Ireland

Skillnet Ireland is a state-funded, enterprise-led body established in 1999. Skillnet Ireland operates a number of specialised programmes that have played a significant role in addressing current and future skills needs in Ireland. Working in close collaboration with its networks, Skillnet Ireland ensures training interventions are relevant to the specific skills needs of participating firms, congruent with the ever-changing world of work, and meeting a high bar in terms of programme design and delivery. On July 25, 2018, Skillnet Ireland announced up to €2 million worth of funding will be made available to industry bodies and enterprise groups to develop new Skillnet Networks. The new enterprise-led learning networks will be launched in 2019 and will support Irish businesses in addressing their current and future skills needs.

SOLAS

SOLAS is an agency of the Department of Education and Skills, established in 2013 under the Further Education and Training Act. SOLAS' functions are to manage, coordinate and support the delivery of this integrated Further Education and Training by the Education and Training Boards (ETBs); to monitor delivery and provide funding based on reliable, good quality data and positive outcomes; and to promote Further Education and Training provision that is relevant to individual learner needs and national skills needs. The work of SOLAS is vital in meeting future skills needs through the Irish talent pool.

Regional Skills Fora

To help foster stronger links between employers and the education and training sector, the Department of Education and Skills has established a network of nine Regional Skills Fora and appointed nine Regional Skills Fora Managers. Each forum provides robust labour market information to inform programme development while encouraging greater collaboration between enterprise and education and training providers to identify and respond to existing and future regional skills needs.

National Skills Council

The National Skills Council was launched in 2017. Chaired by the Minister for Education and Skills, the Council is made up of high-level officials from both public and private organisations. The role of the Council is to oversee research, advise on the prioritisation of identified skills needs and on how to secure delivery of identified needs and will have a key role in promoting and reporting on the delivery of responses by education and training providers to those priorities. Topics that have been recently discussed by the Council include “The Future of Work: The Impact of AI and Automation in Ireland” and “Lifelong Learning”.

Springboard+

Springboard+ complements the core State-funded education and training system and provides free or 90% funded upskilling and reskilling higher education opportunities in areas of identified skills need. The initiative's primary target group when it was established was unemployed people with a previous history of employment. Over recent years with the decline in numbers on the live register the focus was changed to include more people in employment.

Springboard+ courses are at Level 6 (Certificate) to Level 9 (Masters) on the National Framework of Qualifications (NFQ) and are delivered in public and private education facilities around the country. All courses provide job-readiness training and most offer the opportunity for work placement, project-based learning or industry site visits where appropriate. Courses provided for under Springboard+ include those in ICT; Engineering, Manufacturing and Construction; Hospitality; and Business, Administration and Law. Springboard+ 2018 offers 8,088 free places on 245 courses in higher education at certificate, degree and post-graduate level, the majority commencing in Autumn 2018, with some intake in Spring 2019. The majority of courses are part-time for a maximum of 12 months and are open to all eligible applicants regardless of their employment status.

Skills Programmes

Digital Strategy for Schools 2015-2020

The Digital Strategy for Schools 2015–2020 sets out a clear vision focused on realising the potential of digital technologies to transform the learning experience of students by helping them become engaged thinkers, active learners, knowledge constructors and global citizens able to participate fully in society and the economy. It is organised around four themes: teaching, learning and assessment using ICT; teacher professional development; leadership, research and policy; and ICT infrastructure. Schools are supported as they move to embed digital technologies into their teaching and learning practices, and funding is being provided to allow for infrastructural development.

National Skills Strategy 2025

The National Skills Strategy, published in 2016, aims to underpin Ireland's growth as an economy and as a society over the years to 2025. The strategy aims to support development of a well-educated, well-skilled and adaptable labour force, creating and sustaining a strong pool of talented people of all ages living in Ireland. This will be achieved through a series of goals, including a stronger focus on providing skills development opportunities that are relevant to the needs of learners, society and the economy; the active participation of employers in the development of skills; and increased engagement in lifelong learning across Ireland. The strategy identifies technology as one of the key drivers of change in the economy and further identifies skills needs driven by factors such as the adoption of cloud computing, mobile devices, the Internet of Things and Big Data Analytics.

Action Plan for Education 2016–2019

Action Plan for Education 2016–2019, including the Statement of Strategy, was launched in 2016. It sets out the ambition to have the best education and training system in Europe by 2026. Detailed Action Plans for Education are developed and published annually, with specific actions aimed at enhancing education and training in Ireland, to be completed within the year of publication. The 2018 plan focuses on leading in key enabling technologies, championing inclusion and increasing participation in lifelong learning, which will be promoted and supported, as will effective use of skills in the workplace to drive productivity and innovation. It contains actions targeted at increasing those aged 25–64 engaged in lifelong learning to 10% by 2020, and to 15% by 2025. Furthermore, under the 2018 Plan, SOLAS will support up to 6,200 apprenticeship registrations and 3,900 traineeship enrolments throughout the year.

Supporting Working Lives and Enterprise Growth in Ireland: 2018–2021

Supporting Working Lives and Enterprise Growth in Ireland: 2018–2021 is a further education and training policy framework for skills development of people in employment published by SOLAS. This policy is the result of an action in the 2018 Action Plan for Education. This policy draws on a vision of the workplace in Ireland where upskilling during working life is normal practice and has a direct correlation with enhanced job security, higher earnings and autonomy at work for employees. It also draws on a vision where indigenous and multinational firms systematically invest in the development of their staff and in which provision in further education and training which supports employee development is flexible, high quality and accessible. The framework sets out ambitious targets for the next five years for the numbers of those engaged in upskilling (40,500 by 2021) and the number of training programmes available (2,800 by 2021).

Review of Career Guidance

A review of existing career guidance tools and career information for post-primary/further education/higher education students and adults, currently in place across the education and training system was announced in January 2018. The purpose of the review is to ensure that high quality, relevant career guidance support service is being provided to all students from post-primary level up to further and higher education. This review is to be completed by end 2018.

Skills for Growth Initiative

Launched in 2017, the aim of the Skills for Growth Initiative is to increase the quality and quantity of data available on skills needs in individual enterprises, to allow for enhanced engagement between enterprise, education and training providers and other relevant members of Regional Skills Fora. As part of the Skills for Growth project, Enterprise Ireland is providing regional Spotlight on Skills workshops for its client companies to support them to develop a company skills plan and facilitate a focused engagement with their Department of Education & Skills regional representative, to respond to their skills needs. 13 Spotlight on Skills workshops have taken place since Q4 2017, with 121 companies attending, employing 14,912 people.

FIT

FIT is an industry-led initiative that works in close collaboration with government departments and national education and training agencies, local development organisations and a host of community-based organisations. FIT's aim is to create a fast track to marketable technical skills for those at risk of unemployment long term. Training programmes are continually updated and developed with ideas for new courses being informed by emerging technologies and skills areas such as mobile technologies, cloud computing, big data, medical device maintenance and renewable energy technologies. These courses allow for the Irish workforce to yield the most from rapid innovation as they allow people to continue learning.

EXPLORE Programme

The EXPLORE Programme is an innovative initiative aimed at increasing participation rates in lifelong learning and offering an opportunity to upskill for those already in employment. The key objective of this initiative is to create a potential new solution to help address the issue of Ireland's low level of participation in lifelong learning among the Irish workforce, particularly targeting persons over 35 years of age in manufacturing employment. It seeks to:

- Address the lack of digital skills in this cohort.
- Provide a novel approach to overcome barriers to participation in lifelong learning.
- Address the key issue of skills obsolescence which is a significant concern for employers.
- Showcase the benefits of collaboration between local Education & Training providers and industry.

Apprenticeships

Building on the Programme for Government, the Action Plan for Education contains a commitment to enrol 31,000 people on apprenticeship programmes in the period 2016–2020. This represents more than a doubling of apprenticeship activity by 2020.

The 2018 budget allocation for apprenticeship training is €122 million, an increase on the previous year due to increasing craft apprentice registrations and the rollout of additional new apprenticeship programmes. The target for 2020 is to have 78+ apprenticeships on offer, spanning the full range of industry sectors and leading to awards from certificate to PhD level. A total of 25 new apprenticeships are to be provided by the end of 2018. Four new apprenticeship programmes are due to commence in the Higher Education (HE) sectors in the coming months — Culinary Arts, Logistics Associate, Laboratory Technician and Laboratory Analyst.

As well as developments in new apprenticeships, registrations in the craft apprenticeship trades are rising as the employment and economic situation improves. The target of 4,147 set for 2017 was exceeded, with 4,508 new registrations.

Traineeships

A cumulative 10 new traineeships have been developed since 2016. A total of 3,900 traineeship enrolments in 2018 has been set. Previously aimed at unemployed people, traineeships are now open to a wider range of participants, of all ages and backgrounds. In November 2017, a new five-step guide was launched aimed at employers seeking practical information on how to develop a traineeship within their company. Under the Action Plan for Education 10 further traineeships are to be provided by end 2018.

Ireland's First Masters in Artificial Intelligence (AI)

Ireland's first Masters in Artificial Intelligence (AI) was launched in January 2018 in response to a growing demand by industry for AI skills in Ireland. The programme will run in the University of Limerick along with a shorter introductory course on AI in collaboration with the Irish Centre for High End Computing, based at Trinity College. The introductory course started in September 2018 with a target of 60 students followed by the first intake for the Masters in January 2019. Both courses will be delivered predominantly online with some intensive workshops taking place on the university campuses.

An estimated €3.5 million will be invested in this initiative over the next five years, with a target of 300 participants during that period. Skillnet Ireland will fund approximately one third of this cost — including almost all of the development costs — with the remainder being funded through course fees paid by participating companies. The design of the entire programme will be led by ICT companies under the aegis of Technology Ireland ICT, Skillnet Ireland and University of Limerick. In total, 36 tech firms worked on the design of this Masters.

Appendix 5: Members of the Steering Group

Name	Organisation
Kevin Daly (Chairperson)	Department of Business, Enterprise and Innovation
Donal Flavin	IDA Ireland
Helen McMahon	Enterprise Ireland
Margie McCarthy	Science Foundation Ireland
Selen Guerin	SOLAS
Louise Sherry	Higher Education Authority
Paul Redmond	ESRI
Paul Healy	Skillnet Ireland
Laura Bambrick	ICTU
Alison Wrynn	Ibec
Richard Baird	IBM
Robbie Walker	Alltech
Christina Kenny	Abtran
Eric Doyle	Department of an Taoiseach
Joanne Tobin	Department of Education and Skills
Ruth Morrissy (Project Manager)	Department of Business, Enterprise and Innovation
Katherine Griffin	Department of Business, Enterprise and Innovation

Appendix 6: Members of the Expert Group on Future Skills Needs

Name	Organisation
Tony Donohoe (Chairperson)	Ibec
Kevin Daly	Head of Secretariat and Principal Officer, Skills and Education Policy Unit, Department of Business, Enterprise and Innovation
David Hegarty	Assistant Secretary, Department of Business, Enterprise and Innovation
William Beausang	Assistant Secretary, Department of Education and Skills
Kathleen Gavin	Principal Officer, Department of Education and Skills
Keelin Fagan	Enterprise Ireland
Vivienne Patterson	Higher Education Authority
Peter Rigney	Irish Congress of Trade Unions
Ray Bowe	IDA Ireland
Alan McGrath	SOLAS
Selen Guerin	Skills and Labour Market Research Unit, SOLAS

Appendix 7: Glossary of Terms

AR	Augmented Reality
AI	Artificial Intelligence
BDA	Big Data Analytics
BIM	Building Information Modelling
CAGR	Compound Annual Growth Rate
CS	Cognitive Systems
CSO	Central Statistics Office
CX	Customer Experience
DBEI	Department of Business, Enterprise and Innovation
DES	Department of Education and Skills
DIH	Digital Innovation Hub
DLT	Distributed Ledger Technologies
DTIF	Disruptive Technologies Innovation Fund
DTTAS	Department of Transport, Tourism and Sport
EGFSN	Expert Group on Future Skills Needs
ETB	Education and Training Board
EU	European Union
FAT	The Brazilian Fund for the Protection of Workers
F&O	Frey and Osbourne
GDP	Gross Domestic Product
GNI	Gross National Income
HE	Higher Education
ICT	Information and Communications Technology
IDC	International Data Corporation
IoT	Internet of Things
ISIF	Ireland Strategic Investment Fund
IT	Information Technology
ITS	Intelligent Transport Systems
LoB	Line of Business
MSc	Master of Science
NFQ	National Framework of Qualifications
N&Q	Nedelkoska and Quintini
OCR	Optical Character Recognition
PIAAC	Programme for the International Assessment of Adult Competencies
POC	Proof of Concept
PwC	Price Waterhouse Cooper
Q	Economic Quarter
RPA	Robotic Process Automation
SHARP	Sustainable Healthy Agri-food Research Plan
SLM	Selective Laser Melting

SLS	Selective Laser Sintering
SME	Small and Medium Enterprise
STEM	Science, Technology, Engineering and Maths
UCD	University College Dublin
UK	United Kingdom
US	United States
VR	Virtual Reality
WEF	World Economic Forum
WF2020	Workforce 2020
WIT	Waterford Institute Technology

Notes

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