EMEA TECH CITIES
OPPORTUNITIES IN TECHNOLOGY HOTSPOTS

CBRE

CONTENTS

EXECUTIVE SUMMARY

The technology sector in EMEA is a fast-growing and dynamic group of industries, based around a complex system of locational clusters with diverse characteristics, and which are prominent drivers of many office markets in the region.

CBRE has developed a framework for categorising and ranking technology clusters across the region. We have identified four of technology cluster based on scale, extent of sector concentration and growth characteristics. This approach reflects the fact that technology clusters are far from uniform in their structure, specialisms, cost base or interdependencies with other sectors.

Within each category, the rankings reflect a wide range of key locational factors such as the age and educational profile of the labour catchment, the contribution of specific activities to technology employment and the rate of local change in sector output.

Since major capital cities and business centres are often viewed as the default locations for the sector, some of the highly-ranked locations include smaller cities that may not be obvious. However, all have features that make them attractive for certain types of technology company.

This stems from the fundamental importance of labour, and the differences in labour market characteristics between the technology sector and others. These include the higher incidence of contract employment; greater wage visibility and the facility to deliver projects remotely. As a result, the skills profiles of some cities are changing rapidly, as is the ability of technology companies to draw on specialised skill sets in different locations.

By exploring in detail the features of different technology clusters and their labour markets, our analysis provides a framework for occupiers, and investors, to evaluate opportunities in the sector based on their specific skills needs or risk tolerance.

SCALE CLUSTERS

Capital cities and business centres with high-tech-employment > 70,000

1. London
2. Madrid
3. Dublin
4. Budapest
5. Paris
6. Copenhagen
7. Munich
8. Milan
9. Rome
10. = Lyon/Grenoble
10. = Bucharest

SUPER CLUSTERS

Locations with high-tech-employment > 50,000 but < 70,000 and Location Quotient > 1

1. Thames Valley
2. Zurich
3. M3 Corridor
4. Prague
5. Southampton
6. Bristol
7. Rotterdam
8. Cambridge
9. Cologne
10. Vienna

NORMAL CLUSTERS

Locations with high-tech-employment > 20,000 but < 50,000 and Location Quotient > 1

1. Oslo
2. Basel
3. Hamburg
4. Edinburgh
5. Geneva
6. Nuremberg
7. Tallinn
8. Utrecht
9. Brno
10. Brussels

GROWTH CLUSTERS

Locations with double digit growth in high-tech-employment since 2010 and forecast growth in high-tech-employment over next five years

1. Derby/Nottingham
2. Florence
3. Krakow
4. Leeds
5. Vigo
6. Katowice
7. Porto
8. Poznan
9. Augsburg
10. Vilnius

INTRODUCTION

EMEA Tech Cities: Opportunities in Technology Hotspots provides a framework for global occupiers and investors to assess the characteristics of tech clusters in economic, leasing and employment terms, at regional and city level.

Occupiers can take a more informed look at some of Europe's less known but growing tech clusters uncovering opportunities for more effective locational decision-making depending on the sector. Similarly, investors can use the report to assess the underlying demand characteristics of European real estate markets in tech terms, and identify potential investment opportunities.

Major European capitals and business centres are traditionally thought of as the go-to locations for technology companies, but the sector extends far beyond this. We have analysed over 250 cities across Europe and highlighted 40 top tech clusters in four groupings, demonstrating the breadth, depth and strength of locations in one of the fastest growing business sectors globally.

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OPPORTUNITIES IN TECHNOLOGY HOTSPOTS

METHODOLOGY

How do we categorise and rank tech clusters in such a diverse region? Based on their size, growth and labour market characteristics, tech locations can be separated into four categories: we term these **Scale Clusters**, **Super Clusters**, **Normal Clusters** and **Growth Clusters**.

To develop a ranking within each category, indicators were weighted depending on the defining characteristics of each category. For example, hi-tech and knowledge intensive employment scale, Location Quotient (LQ), technology Gross Value Added (GVA) and forecast growth in tech employment were among the factors used to derive the rankings.

The underlying data for this analysis is Eurostat data for all European NUTS 2 regions up to the full year 2016 (accessed October 2017). For any region where there was no 2016 data, the most recent year was used as a proxy. Forecast employment growth figures are provided by Oxford Economics (2017).

60 variables were collected (including calculated variables). Any location with less than 20,000 in hi-tech employment was then disregarded, as these were deemed to be too small to warrant further analysis.

The remaining locations were then grouped into four cluster types based on the following criteria:

SCALE CLUSTERS
Capital cities and business centres with more than 70,000 people in high-tech employment

NORMAL CLUSTERS
Locations with more than 20,000 in high-tech employment but less than 50,000, and with a location quotient of more than one

SUPER CLUSTERS
Locations with more than 50,000 people, but less than 70,000, in high-tech employment, and with a location quotient of more than one

GROWTH CLUSTERS
Locations with double-digit growth in high-tech employment since 2010, and forecast double-digit growth in high-tech employment over the next five years

For the full cluster and ranking list, please see appendix

CLUSTER CHARACTERISTICS: THE IMPORTANCE OF LABOUR

Labour is fundamental to the success of the tech sector, whether in traditional sectors, such as software or sectors where technology plays an increasingly pivotal role, such as automotive.

Tech sector employees differ from those in other more traditional sectors in that many are employed on a contracted rather than permanent basis. Employees are continually checking job boards and online adverts and therefore have near-perfect information on the value of their input. In overall terms, the tech sector tends to have fewer barriers to entry than established sectors which are reliant on more traditional channels and routes to market. Establishing a tech brand is often done entirely online. So, new companies don't always need to establish a network of local or regional offices to grow. Regional presence tends to be a consequence of growth, rather than the direct enabler.

On salaries, the tech sector is much more transparent than other sectors. Workers are typically paid for outputs which can often be delivered from any location. When they respond to tenders / requests they do so online and so have excellent visibility of the rewards. They use social media and online forums to share company intelligence so employer reputations are built online, rather than purely through their physical presence.

All of this can reduce regional disparities in labour cost, as freedom of movement of labour within the EU means that projects can be easily delivered remotely regardless of whether the employee needs to sit alongside their employer. This applies particularly to scarce talent such as developers, whereas for back office IT operations there may still be large cost differentials especially between Western Europe and Central Eastern Europe (CEE).

Even with this highly mobile workforce, clusters still exist, and the drivers of this clustering differ, which is why we have grouped locations into cluster types based on their characteristics, rather than a straightforward data-based ranking.

SCALE CLUSTERS – Capital cities, second cities or regional business centres

The development of the tech sector is often to support activity in other sectors, so fintech develops to support financial services, digital to support media and so on. This interdependence is one of the key reasons why major diverse commercial centres feature as major concentrations of tech sector activity.

Some cities have seen significant growth from indigenous companies, whilst others have developed through foreign direct investment – for example Dublin, Budapest and Bucharest. The attractors of those cities differ. Dublin's success has been supported by strong government investment promotion, particularly towards US companies who have been sold on the cultural affinity and attractiveness of the city to young talent from across Europe. Google, Facebook, Accenture, Airbnb, Trip Advisor and Indeed all have a major presence in the city.

Budapest and Bucharest had the advantage of labour cost arbitrage over Western European cities, but this has started to erode in the tech sector as people work remotely and those in the gig economy align their fees to their Western European counterparts. For example, Ericsson, Nokia, evo-soft and Morgan Stanley all have software developer presence. Bucharest has long been an attractive destination for companies seeking lower cost IT talent including companies like: Oracle, IBM, Luxoft, Endava, Ericsson, Bitdefender and Deutsche Bank.

SUPER CLUSTERS – Mix of established tech locations, and locations where tech has grown to support a specific sector or set of sectors

Many of the established tech locations, such as the Thames Valley and Cambridge in the UK, were built by traditional IT and software companies locating there to attract talent often from universities with high quality software graduates. Many of the companies have been in situ for 30 years or more, such as Microsoft in Reading, UK.

The cities where tech has grown to support a specific sector include Bristol, where tech has grown to support the aerospace sector and Vienna to support the administrative HQs of transnational organisations such as the UN. In this sense, many of the cities in this grouping are directly linked to, or dependent on, other major employment sectors or public bodies in the vicinity.

NORMAL CLUSTERS – Smaller capital cities and regional business centres supported by universities producing tech graduates

These cities have some similarities with super clusters and scale clusters, but where tech has not developed to the same extent due to scale.

Edinburgh, for example, has a strong financial services sector, devolved government, and a good university producing computer science graduates. RBS, Sky, Standard Life Aberdeen and Lloyds Banking Group all have a major IT presence.

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OPPORTUNITIES IN TECHNOLOGY HOTSPOTS

Cities in this cluster tend to be those where costs are lower than other cities in the same country, or cities in neighbouring countries. They can be cities where companies chose to locate a second tech centre, or centre of excellence. Often companies will choose locations where they will be an employer of choice, rather than competing with others for the same talent.

GROWTH CLUSTERS – Smaller but fast-growing, often niche locations

This cluster is perhaps the most interesting of all, as it demonstrates the footloose nature of the sector.

Many of the location selection criteria adhered to in other industries are less prevalent in the tech sector. For instance, proximity to universities, and fibre cost and speeds were historically cited as motives when choosing a tech location. Today tech talent no longer necessarily has a degree, technologies change faster than academic institutions can change their programs, and fibre speeds and costs in CEE countries are as good as, and in some cases better, than those in Western Europe. In this light, the importance of physical proximity to customers and markets is diminishing and remote delivery of services becoming more common. If companies don't need to be in a major city or established tech centre, then why not localise in areas where competition for talent is likely to be less fierce?

Companies that drive this cluster are also overwhelmingly focused on their business. Whilst they may deal in common technologies their products and value propositions are unique. They are often not bound by legacy locations, or historical ties to cities or countries and real estate is not their primary concern, but simply an enabler. So rather than a need to co-locate, this cluster is perhaps more a function of places having the right combination, or a good enough combination of factors from which to operate successfully.

As a result, there is less commonality between cities in this cluster than in the others. Some have grown supporting other sectors, others are low labour cost destinations in CEE and others are second tier cities and regional business centres. Many are cities that are "cool" to work in for lifestyle reasons, rather than the legacy of an established tech sector.

Talent perspectives are also changing. Millennials are used to taking risks and often do not aspire to work for large brands, Forbes, FTSE or NASDAQ companies. To them the gig economy is the norm rather than the exception. Start-ups, where they can take ownership of a product or activity are where they turn to for advancement. In many cases they would rather become a big tech company than work for one.

DEFINING THE TECH SECTOR

So, what do we mean by the tech sector when classifying companies? Broadly speaking, we break it into ten categories:

TRADITIONAL TECH

SOFTWARE
Companies creating, delivering, maintaining or servicing software products and services, either on licence or on the cloud.

IT SERVICES
Typically companies acting as IT outsource organisations for clients, designing and delivering bespoke IT service solutions.

TELECOM
Companies specialising in the delivery of communication hardware and services, ranging from wireless and satellite companies to internet and cable providers.

HARDWARE
Firms that design and build physical technology products.

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OPPORTUNITIES IN TECHNOLOGY HOTSPOTS

NEW TECH

WEB
Companies whose primary means of delivering services is online. Companies can range from social media sites to search engines.

E-COMMERCE
Any company whose primary or original focus is facilitating the trade of goods and services online. Companies range from online marketplaces to online shopping and delivery services.

DIGITAL ADVERTISING/MARKETING/MEDIA
Advertising and marketing activities with a digital focus, and media or publishing companies with an explicit digital element.

GAMING
Companies involved in the production of games online, as apps or for consoles.

FINTECH
Challenger banks and start-up financial services firms.

CYBERSECURITY
Companies selling services protecting against the criminal penetration of data systems and company tech infrastructure.

SECTOR LEASING PATTERNS

Analysis of completed office leasing transactions in the technology sector across Europe over a two-year period reveals a dynamic picture of activity. Doing this enables us to explore the recent demand picture in Europe, beyond analysing purely the economic and recruitment factors that reflect longer-term dynamics.

Firstly, traditional technology companies still dominate tech activity across Europe in real estate terms – 65% of all deals we tracked fall under software, IT services, telecom or hardware.

Secondly, although traditional tech sub-sectors dominate, there are regional differences. Activity is far more even across sub-sectors in Western European markets than in CEE. New technology companies account for a greater share of total tech transactions in Western Europe than they do in CEE, demonstrating the higher incidence of start-up and SME activity in Western European cities than elsewhere in the region.

Cluster comparison: Sub-sector differences

The picture is more nuanced when looking at the sub-sector mix across the four different cluster types.

Locations in the Scale Cluster have the most even balance of sub-sectors, and have more new tech activity than any other cluster type (40%). There are several explanations for this: the scale clusters mostly comprise capital cities and major European business centres where there is greater scale and higher concentration of labour. In conjunction with an abundance of venture capital, ancillary services and a highly educated labour force, scale clusters are the most conducive to start-up and SME activity, where new technology companies are likely to proliferate. Traditional tech activity still makes up the majority of leasing deals though, highlighting the importance of incumbent technology companies in markets despite a rise in innovative technology at the smaller end of the market.

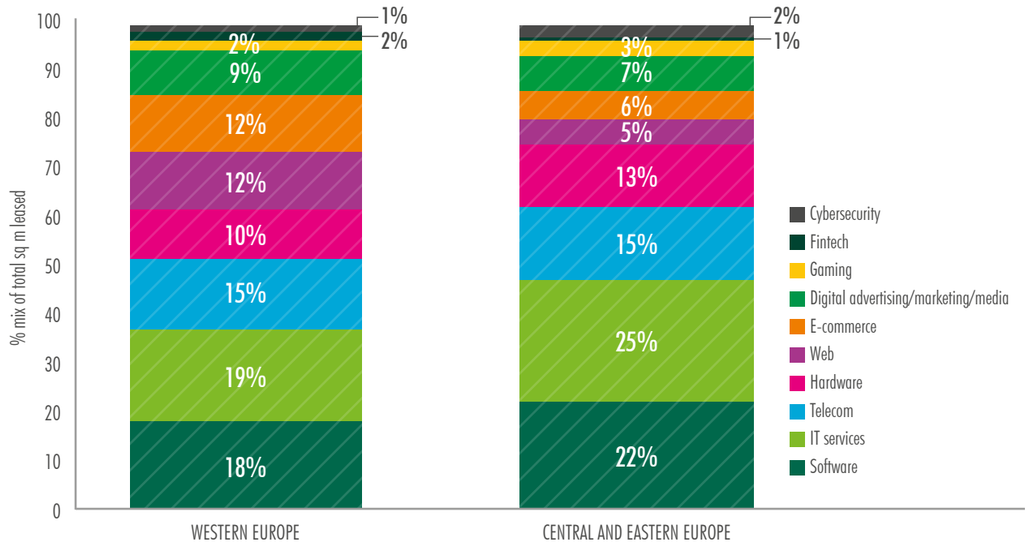
Super Clusters on the other hand are the most reliant on software and IT services. Cities in this cluster typically have high location quotients and access to a large pool of tech labour – the technical, skilled labour as well as supporting service/marketing labour that typically make up the base of software and IT services type of activity.

Normal Clusters, while dominated by traditional tech activity, have the highest concentration of digital advertising, marketing and media activity. This is largely attributable to the fact that the cities in this cluster are medium-sized but nevertheless creative destinations – in many cases more so than those in the super cluster category. Tenants in this cluster tend to be domestic, though there are some cases of companies expanding here from the USA and China.

Growth Clusters, on the other hand, demonstrate the conditions for future growth but in many cases currently serve as outsourcing, mid or back-office function locations for large corporate technology companies. This explains why these clusters are the most highly dominated by traditional tech activity, and reinforces the importance of matching the type of business activity with the appropriate location when making a location decision.

FIGURE 1: A BIRD'S EYE VIEW: TRADITIONAL TECH DOMINATES (2016-17)

Completed tech leasing deals



SOURCE: CBRE RESEARCH 2018

FIGURE 2: WHICH SUB-SECTORS DOMINATE? (2016-17)

Completed tech leasing deals by sub-sector and cluster

SOURCE: CBRE RESEARCH 2018

CLUSTER COMPARISON: ANALYSIS OF DEAL SIZE

Given the diversity in tenant base and market drivers, how do average deal sizes compare across the various clusters?

As might be expected, the largest average deal size can be found in Scale Clusters. Locations within these clusters are typically regional (in some cases global) business centres that attract the largest global tech corporations, who typically establish HQ or front-office buildings in these markets. Similarly, the average deal size in Growth Clusters is larger relative to super and Normal Clusters, largely due to the breadth and scale of traditional technology activity in these cities, mainly as mid- or back-office functions.

At the other end of the spectrum come super clusters, where the average deal size is just under 1,000 sq m. On the surface, this may seem contradictory given the popularity of such locations for large multinational corporations, but the underlying reason is smaller deals from software and digital advertising/marketing/media companies, which have average deal sizes of 703 sq m and 536 sq m respectively.

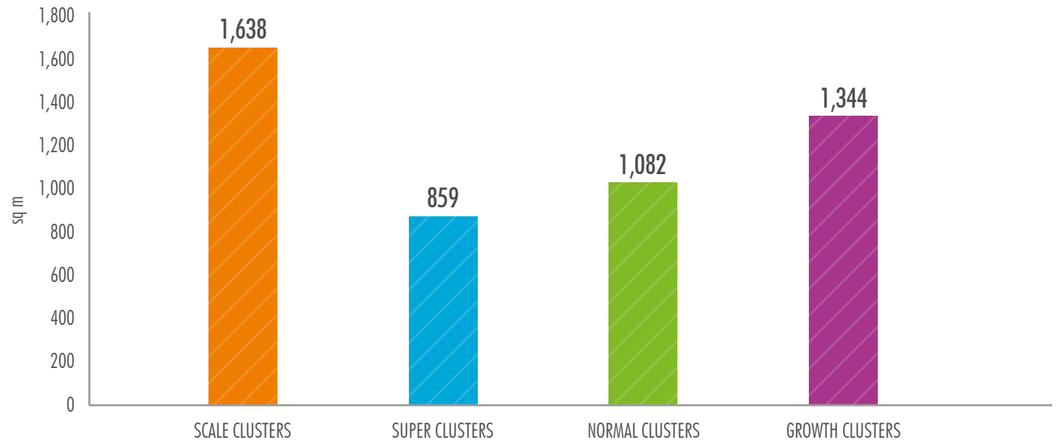
Average lease size across sub-sectors

The e-commerce sub-sector accounts for the largest average deal size of leasing transactions, which reflects the aggressive growth of the sector across industries. Berlin for instance has attracted larger e-commerce floorplates than anywhere else in the region. Berlin is also one of the four main hubs for web activity, along with London, Dublin and Amsterdam, reinforcing the point that Scale Clusters are more attractive for 'new' tech sub-sectors than other cluster types. Telecoms, the largest traditional sub-sector in terms of average deal size, is well represented in Paris, though also has a significant presence in Moscow and Bucharest.

Overall, while new tech companies make up a far smaller proportion of total deal flow than traditional sub-sectors, they are just as space-hungry as the more traditional companies in terms of average deal size. This reflects differences in growth speeds of companies within each of these two categories in the global marketplace, with the new tech sector seeing particularly rapid growth.

FIGURE 3: AVERAGE DEAL SIZE (2016-17)

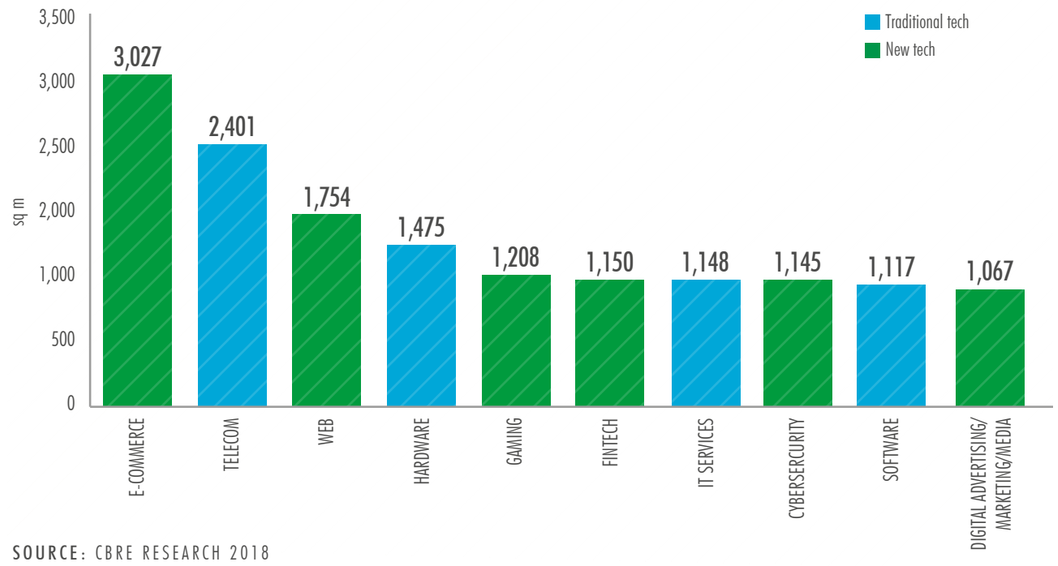
Average size of tech leasing deals (all cities)



SOURCE: CBRE RESEARCH 2018

FIGURE 4: E-COMMERCE DOMINATES AVERAGE DEAL SIZE (2016-17)

Average size of completed tech leasing deals by sub-sector (all cities)



SOURCE: CBRE RESEARCH 2018

FOCUS ON TALENT

Vertical sector vs Horizontal activity

There are two ways of looking at the tech industry in terms of talent;

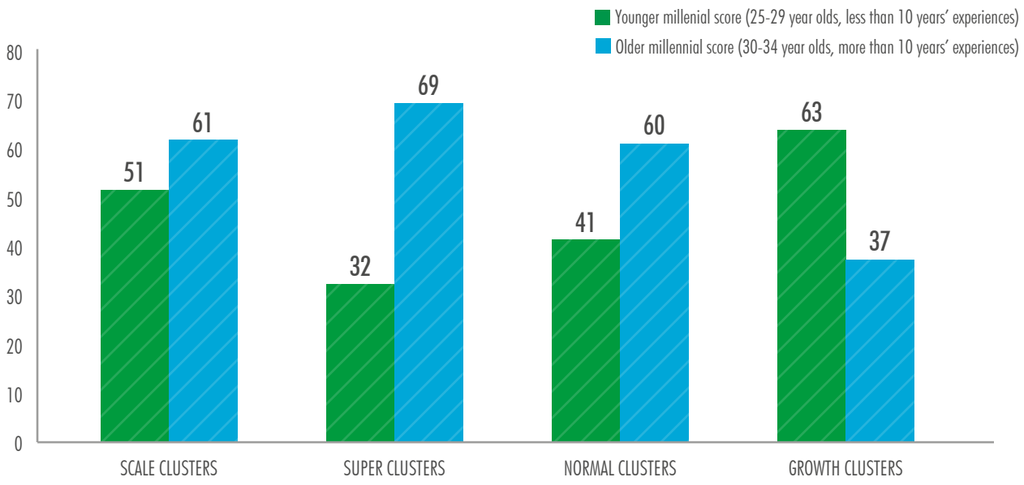
- Traditionally it has been viewed as a sector in itself, dominated by traditional large IT service companies, consultancies and major telecom service providers. This is how we have viewed tech so far - as a vertical sector.
- Increasingly it has become more of a horizontal activity, which cuts across all business sectors. This is to say that there is substantial, and in many cases rising, tech employment activities contained within other industries. This means that two approaches are required to understand tech labour market characteristics.

At a high level, there are three key insights that are consistent across the whole of Europe.

- Tech professionals with under ten years' experience are significantly more likely to work for SMEs with under 200 employees
- Tech professionals with over ten years of experience are significantly more likely to work for very large companies with over 5,000 employees. This trend is even more pronounced for software development professionals where up to 50% of those with less than ten years of experience work for an SME.

FIGURE 5: EXPERIENCE SCORE: TECH AS A VERTICAL INDUSTRY

Experience score of millennials working in the tech sector



SOURCE: CBRE RESEARCH, LINKEDIN 2018

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When analysing the age profile of employees in both the tech sector and software development professionals across the four types of clusters, another clear trend emerges;

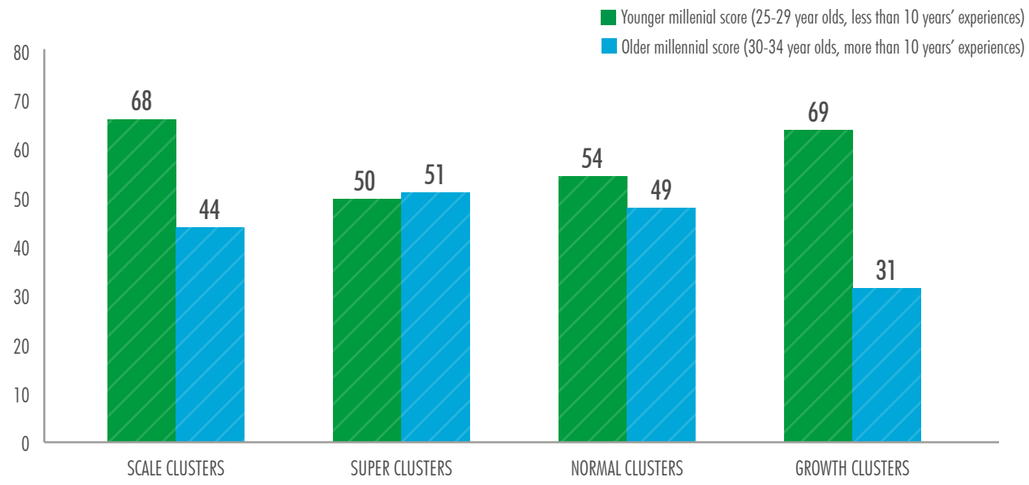
- Employees with under ten years' experience are far more likely to work in a Scale Cluster city than in Super or Normal Cluster cities. This can be explained by the overall pulling power of these Tier 1 capital cities to graduate talent
- Employees with under ten years' experience make up over a third of total Employment in Growth Cluster cities. This can be explained by the relatively immature technology sectors in these high growth cities meaning that employees with over ten years' experience are in short supply
- In Super and Normal Cluster cities, more than 50% of total employment in tech and over 50% in software development employment is made up of employees with over ten years' experience.

To assess tech labour both as a vertical sector and a horizontal activity, we have used data from LinkedIn to look at the experience profile of tech and software development labour across our clusters and cities. Our four types of clusters and cities within them are given a 'younger' millennial and 'older' millennial score based on the location quotient of 25-29 year olds and 30-34 year olds in each city, and the proportion of people with less than versus more than ten years' experience in each group. This results in a composite indicator for the balance and concentration of diverse types of labour across cities. The higher the score, the greater the proportion and concentration of labour within that category.

Millennial Location Quotient x Experience Level = Experience Score

FIGURE 6: EXPERIENCE SCORE: TECH AS A HORIZONTAL ACTIVITY

Experience score of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

OCCUPIER AND INVESTOR IMPLICATIONS

Occupier and investor implications

The Tech Industry as a Whole

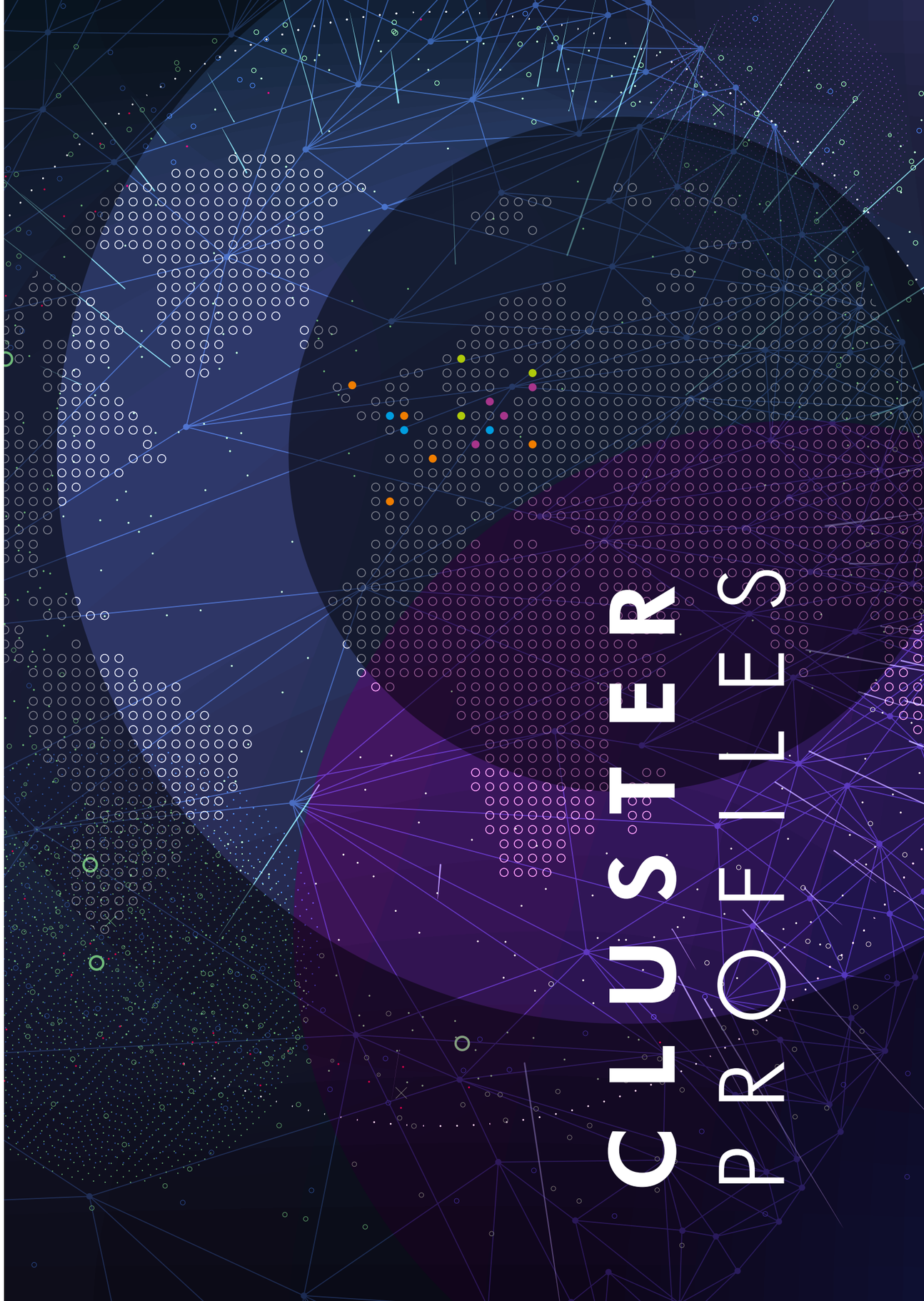
- Traditional tech companies still dominate the European market, despite continued growth from the new tech sectors.
- There is a greater representation of new tech activity in Scale and Growth Clusters than in Super or Normal Clusters.
- Scale clusters will continue to support a diverse balance of different company and labour types, while Growth Clusters may well see a growing proportion of domestic start-ups engaging in new technology activities as well as global corporates expanding to take advantage of diverse labour pools.

Tech Companies as Office Occupiers

- Depending on the tech sub-sector and business strategy, occupiers will be able to agglomerate with peers within the same sub-sector, or identify a different sub-sector that offers adjacency benefits.
- Europe has a very diverse labour pool – depending on the business activity, the labour requirements will be different. Our analysis provides a framework for assessing locational opportunities according to the nature of the activity and particular skills requirement.

Real Estate Investors

- The four cluster types present a framework for investors to assess suitable investment opportunities depending on their investment strategy and risk tolerance. Core investors with a long income focus may look first at cities in Scale Clusters; those with a more opportunistic scope may look more to the Growth Clusters.
- Understanding underlying demand conditions using this framework helps inform potential leasing strategy, both for existing stabilised assets and new developments.



SCALE CLUSTERS

LONDON

London is our top-ranking technology cluster. The city is a magnet for young millennial talent, and employment in the tech sector has grown by 20% since 2008 and its sector location quotient means the proportion of tech employment is almost two and a half times the EU average. London's traditional tech sector is dominated by more experienced professionals with older millennial (more than ten years' experience) index score of 90 compared to 58 for young millennials (less than ten years' experience).

London has a strong sub-sector mix with no single one dominating its employment reflecting the city's position as one of the world's leading technology centres.

Major employers in the IT services sub-sector include Capgemini & Cognizant; the largest employers in the software sub-sector include Microsoft and Oracle and in telecoms the city is home to major operations for BT & Vodafone. Other top employers of tech talent in London include Accenture, IBM, and Thomson Reuters.

When looking at software development as a cross-sectoral activity, the employee demographics are almost the reverse of the tech sector.

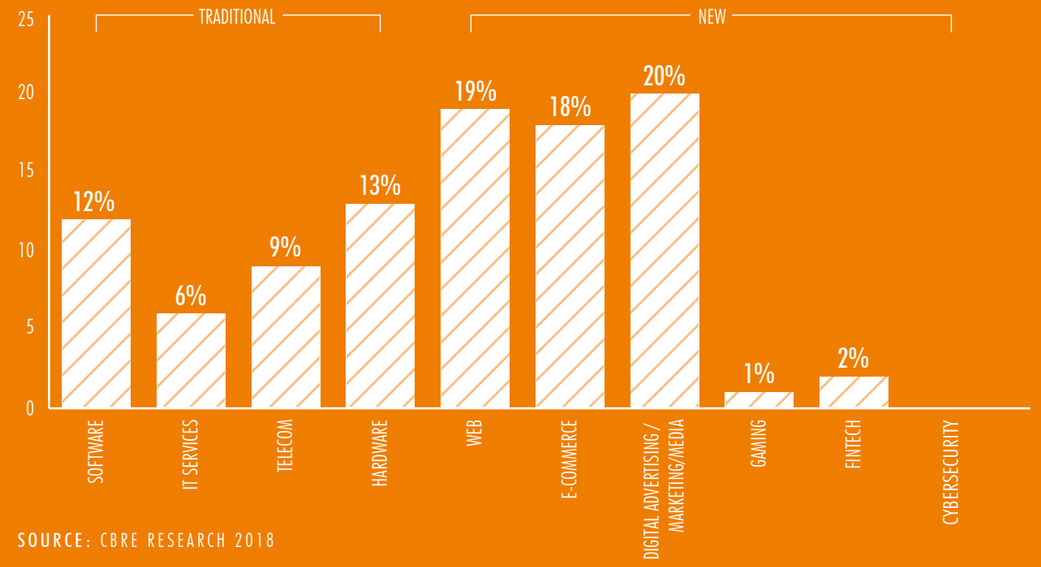
Younger millennials dominate the labour market and far outnumber those with more than ten years' experience.

There is a significant difference in the type of companies which are the top employers of software development talent compared to the tech sector. Those with less than ten years' experience are far more likely to work for modern tech companies with Google, Facebook and Amazon amongst the largest employers in this demographic. The only financial services company among the largest employers of those with under ten years' experience is Bloomberg.

There is also a clear divide in employee choices dependant on experience level; for developers with over ten years' experience, the top ten largest employers are dominated by banks including Barclays, UBS, Credit Suisse and RBS, while no bank appears in the top ten largest employers of developers with under ten years' experience. This poses a challenge for established traditional tech companies and banks as less experienced millennials appear to be more strongly drawn to the newer brand of tech companies.

FIGURE 7: LONDON TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

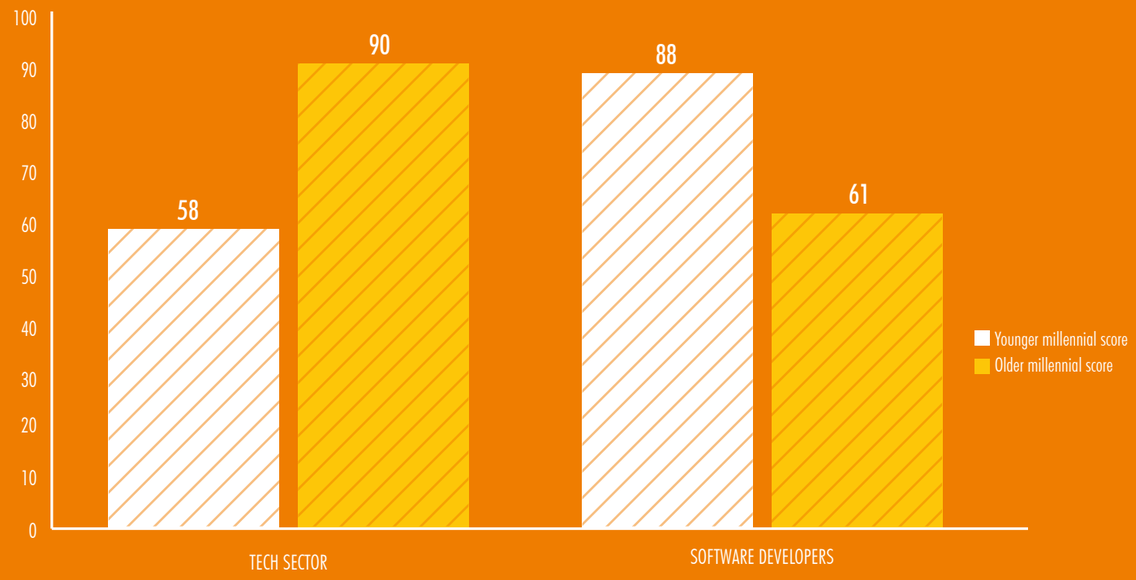
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 8: LONDON EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

MADRID

Madrid's tech sector employment base is the third highest in Europe after London and Paris, and as a Scale Cluster city, its tech sector is dominated by employees with over ten years of experience. It is one of the few cities to have seen negative employment growth in tech since 2008, reflecting the impact that the financial crisis had on the Spanish economy. Despite negative employment growth, Madrid's tech location quotient is amongst the highest in the EU.

Madrid's tech sector is dominated by large companies, and in contrast with other scale cluster cities, the list of largest tech employers in Madrid is not dominated by US-based companies. Domestic companies like Telefonica and Indra are amongst the largest employers.

The telecoms sector makes up the majority of Madrid's largest ten tech employers with Telefonica, Vodafone, Ericsson and Orange all featuring amongst the largest employers in the tech sector. Technology/hardware companies Indra and IBM have major operations in Madrid and in the IT services sub-sector Atos, Everis, Hewlett Packard Enterprise and Sopra all feature amongst the largest employers.

Similarly to Dublin, Madrid's software industry is also dominated by those with more than ten years' experience – these two cities are unusual in this sense as across all clusters, as the general trend is for younger millennials to dominate the software sector.

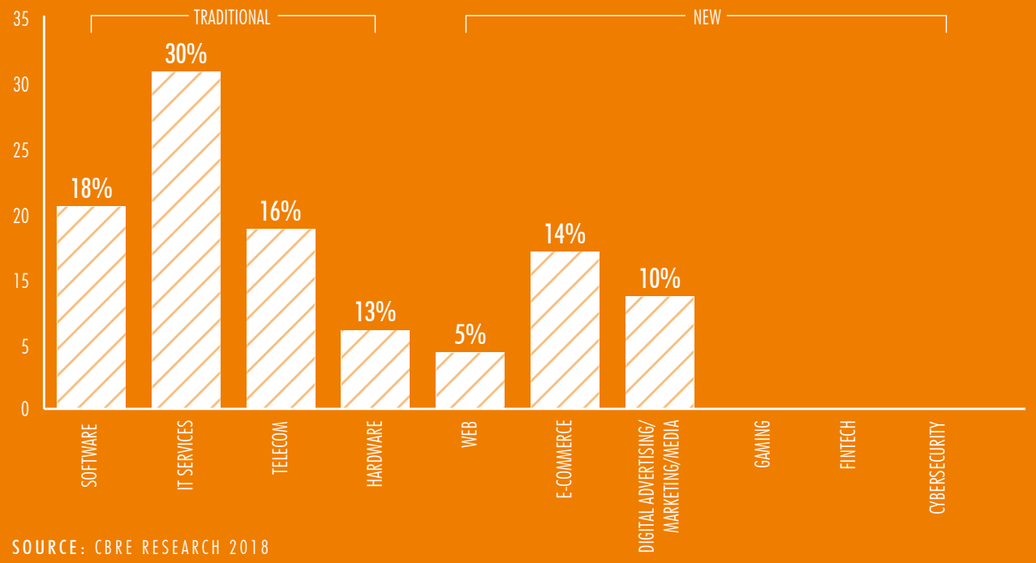
Madrid's software development employers are not as dominated by very large companies compared to Dublin. 45% of those with under five years' experience work in SMEs, which drops to 40% for those with over ten years' experience.

The largest employers for the less experienced developers in Madrid are from the IT service sector with companies like Everis, Sopra Steria, GMV, VASS and BABEL featuring amongst the largest employers. There is a large divide between experience levels in Madrid with telecoms companies Telefonica, Ericsson and Tecnocom featuring in the top ten largest employers of talent with over ten years' experience but not featuring at all in the top ten employers of those with less than ten years' experience. This presents a challenge to the telecoms industry in Madrid as it suggests that younger millennial employees are choosing to build their careers in other sectors.

EMEA TECH CITIES
OPPORTUNITIES IN TECHNOLOGY HOTSPOTS

FIGURE 9: MADRID TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

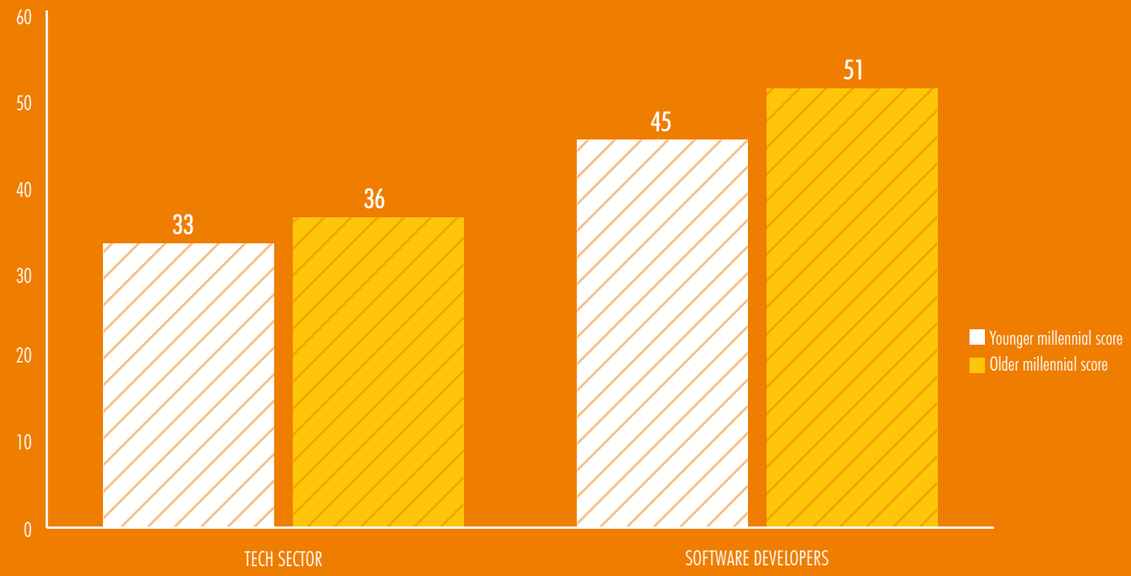
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 10: MADRID EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

DUBLIN

Dublin's traditional tech sector is dominated by employees with over ten years' experience which is in line with other Scale Cluster cities.

The tech sector in Dublin has a heavy focus on very large organisations with no difference across different experience levels as witnessed in other cities. This is likely to be a result of the dominance of multinational American technology companies who have chosen Dublin as the location of their European headquarters, drawn in by its deep and talented labour pool and its attractive corporate tax environment.

The largest sub sectors in Dublin's tech sector are software, professional services and technology/ hardware companies. Accenture, IBM and SAP are the largest employers of young millennials whereas the largest three companies for older millennials are IBM, Dell and Microsoft. Google and Salesforce also have large operations in Dublin making it one of the most concentrated tech hubs in Europe.

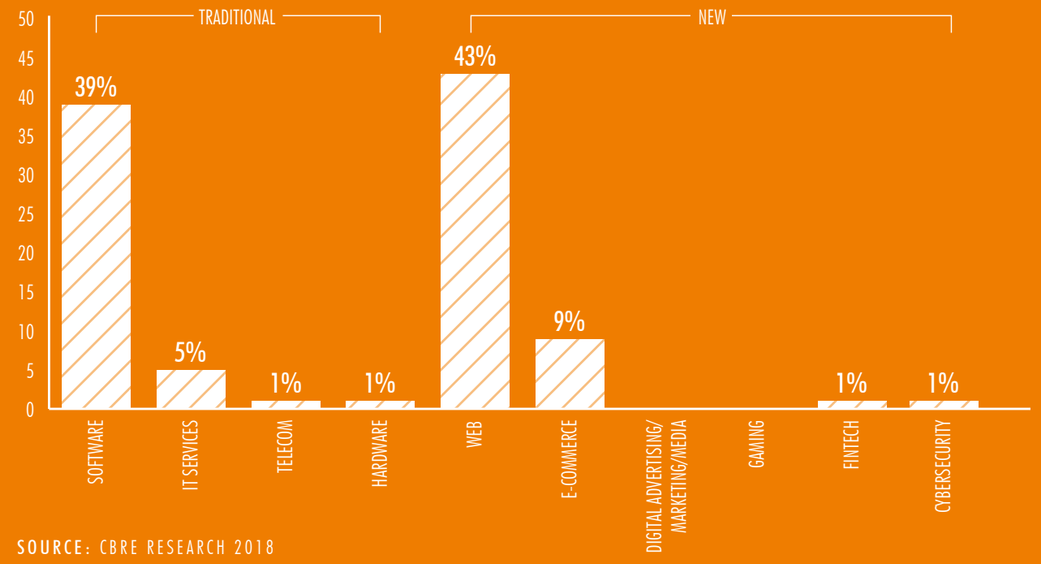
Dublin's software development professionals are similar in experience levels to the tech sector, with older millennials dominating the labour market. This is unusual for scale cities where the age profile of Software developers tends to be dominated by those with less than ten years' experience.

Very large and typically US based companies dominate Dublin's employment of software developer talent with IBM, Amazon, Accenture, Dell, Intel, Salesforce among the major employers within the city.

The largest sectors for the employment of developers are software, hardware and fintech. Fintech company Workday is one of the largest employers of Software talent and online credit platform Equifax are another major employer in this area. Fidelity Investments also feature amongst the largest employers.

FIGURE 11: DUBLIN TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

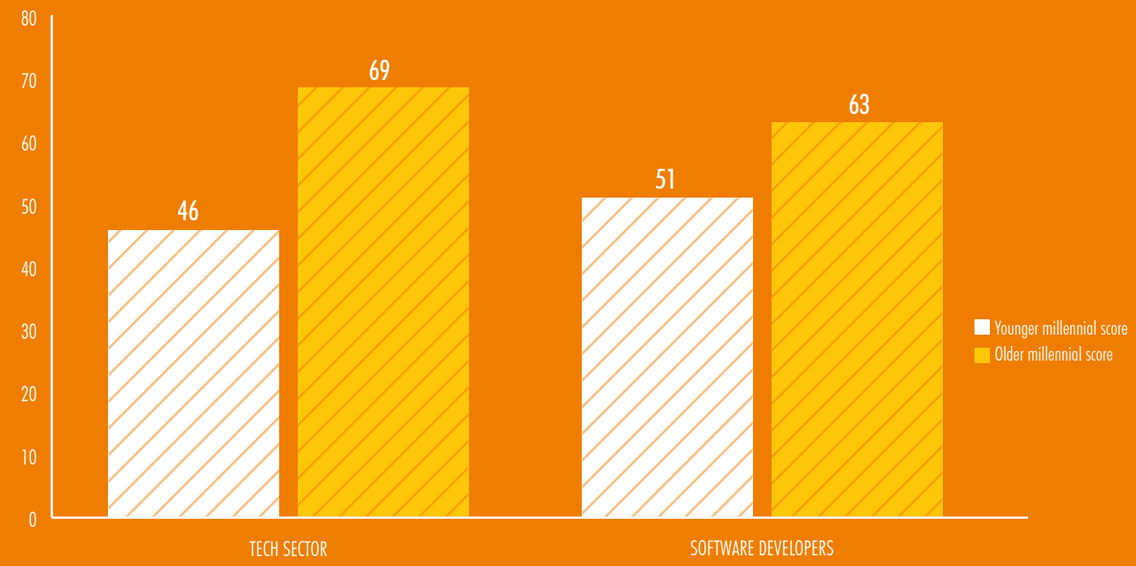
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 12: DUBLIN EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

PARIS

Paris is the fifth-ranked of the Scale Cluster cities in our analysis. Employment in tech is the second highest in Europe at just under 325,000 meaning that alongside London, these two cities have comfortably the largest clusters in terms of total employment. Paris has an Tech Location Quotient of 2.0 meaning it has double the EU average percentage of employment in the sector.

Total employment in the sector has declined since 2008, which is at odds with other major European technology clusters which have mostly experienced high growth. London for example has expanded by 20% over the same period. This negative growth figure was a factor which counted against Paris in this analysis.

Paris' tech sector is largely dominated by indigenous French multinationals with the largest employers including telecoms giants Orange, Bouygues and SFR. Other major French companies with significant operations in the city include Sopra Steria, Capgemini and Atos. Paris is also home to global Engineering & Technology companies Dassault Systèmes and Altran.

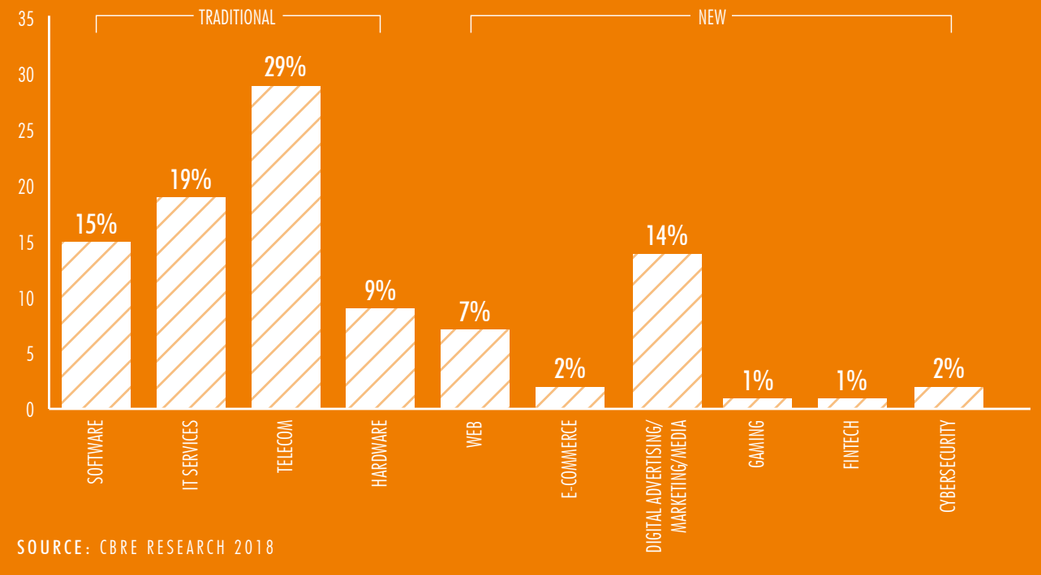
The experience profile of Paris' tech sector is dominated by millennials with less than ten years' experience. this is at odds with other scale cluster cities whose tech sectors tend to be dominated by millennials with more than ten years' experience demonstrating Paris' ability to attract young talent.

When looking at software development as a cross-sectoral activity, the demographic of Paris' labour force is even more dominated by younger millennials with under ten years' experience as seen in most other European cities.

The largest employers of software development talent in Paris are from a broad range of sectors. These include BNP Paribas and Societe Generale from the banking sector and engineering giant Thales. Paris has also spawned fintech company Murex has also given birth to fintech company Murex who focus on capital markets and Criteo who are experts in commerce marketing. Both are major employers of software development talent in the city and reflect Paris' ability to incubate and scale innovative technology companies.

FIGURE 13: PARIS TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

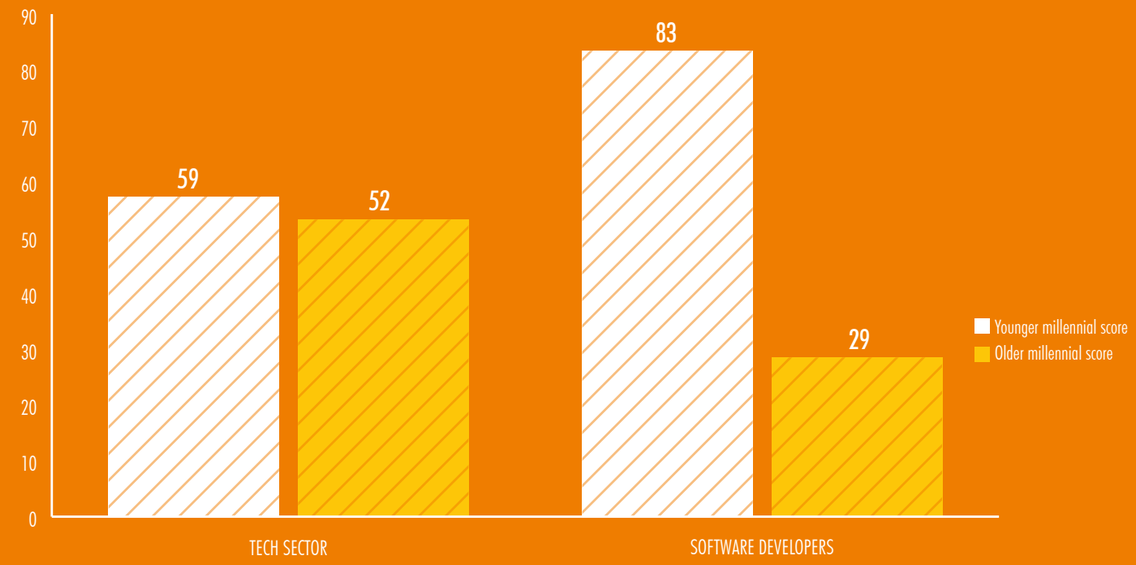
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 14: PARIS EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

BUCHAREST

Employment in Bucharest's tech sector has experienced growth of 66% since 2008 meaning that the city has some of the strongest sector growth in Europe. Bucharest's growth has resulted in a location quotient that is more than double the EU average. The age profile within the tech sector in Bucharest is fairly even between younger and older millennial talent, which contrasts with the trend in Scale Cluster cities where the sector is typically dominated by more experienced professionals.

Bucharest is the city whose tech sector is most dominated by very large international companies, which is largely the result of its Bucharest pre-eminence as one of Europe's major nearshore tech centres with many global companies having large operations in the city.

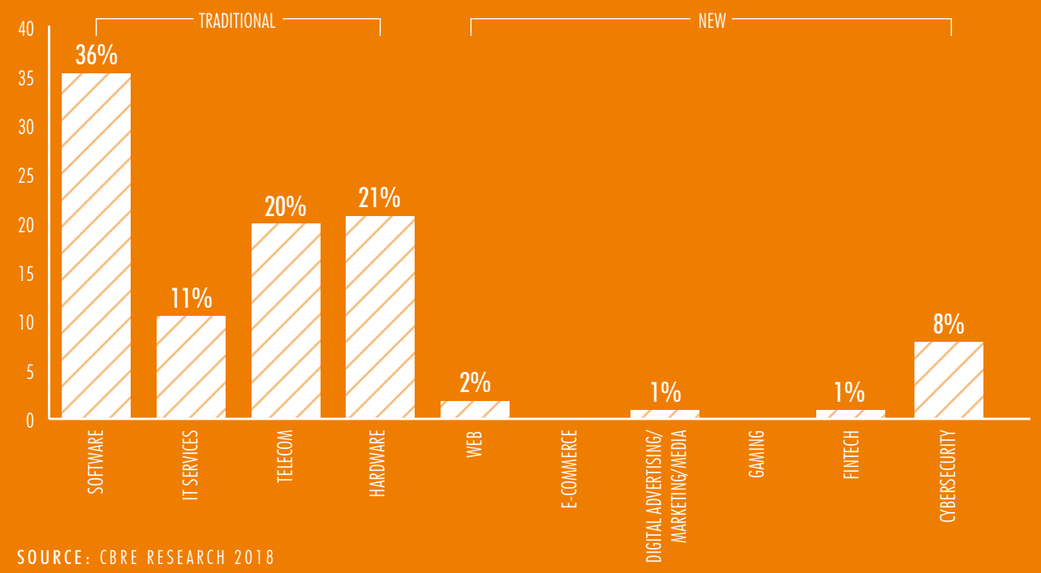
The largest sub-sectors in Bucharest's tech sector are software and telecoms with Oracle, Microsoft, Vodafone and Ericsson having major operations in the city. Another significant sub-sector in Bucharest is IT services with major players in the city including Luxoft and Hewlett Packard Enterprise.

The talent pool of developers in Bucharest also has a younger profile than in more established technology clusters. This is largely driven by the huge growth in the industry over the past decade in Bucharest. As with the tech vertical sector, the companies that developers work for in Bucharest tend to be larger with very large companies making up over 45% of employment across all levels of experience.

IT services is the largest sub-sector for development talent in Bucharest with Luxoft and Endeva being two of the largest employers in the city. Bucharest also has an emerging cybersecurity sector, with the largest employer of development talent in this area being the fast-growing Romanian company Bitdefender. Bucharest is also home to gaming companies Electronic Arts and Ubisoft which are major employers of software development talent in the city.

FIGURE 15: BUCHAREST TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

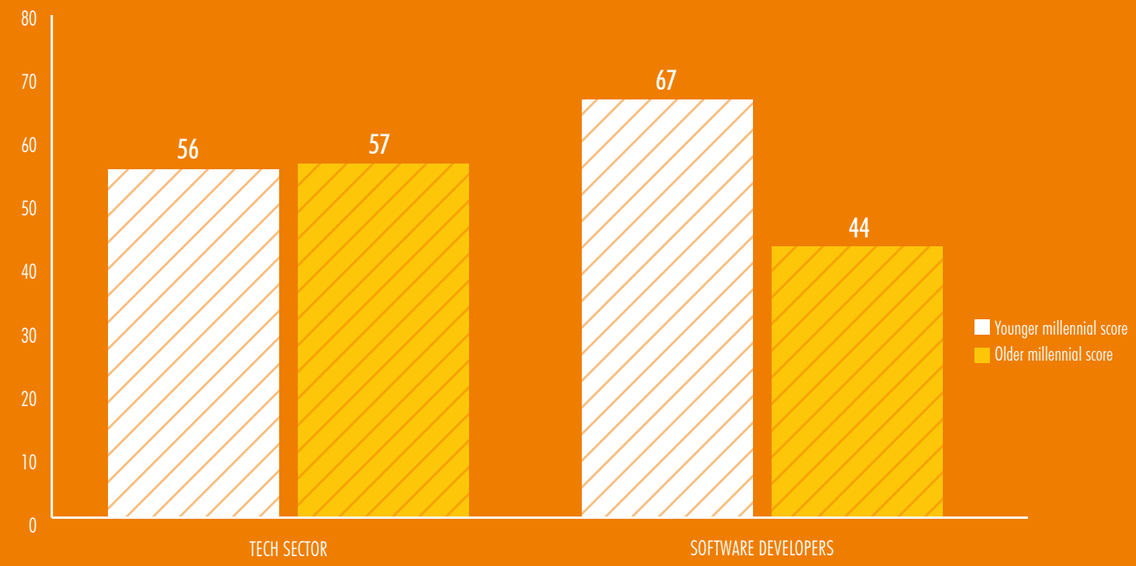
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 16: BUCHAREST EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

SUPER CLUSTERS

THAMES VALLEY

The Thames Valley region is one of the most established technology clusters in Europe, reflected in the experience profile of the employees within the tech industry where the workforce is dominated by those with over ten years' experience. Alongside Oslo, this makes it the most experienced tech workforce of all profiled cities and reflects the Thames Valley's position as one of Europe's most mature clusters.

The Thames Valley is dominated by very large organisations which make up more than 62% of employment for employees with more than ten years' experience. SMEs make up less than 30% of employment across all experience levels.

Telecoms, IT services and software are the dominant sub-sectors in the cluster with major employers being largely global tech companies including Vodafone, Huawei, Telefonica, Microsoft, Oracle and Hewlett Packard Enterprise.

The experience profile for software developers is slightly different from the overall tech sector but it is still more dominated by those with over ten years' experience than other Western European markets. The proximity to London means that competition for top young development talent is high in this region.

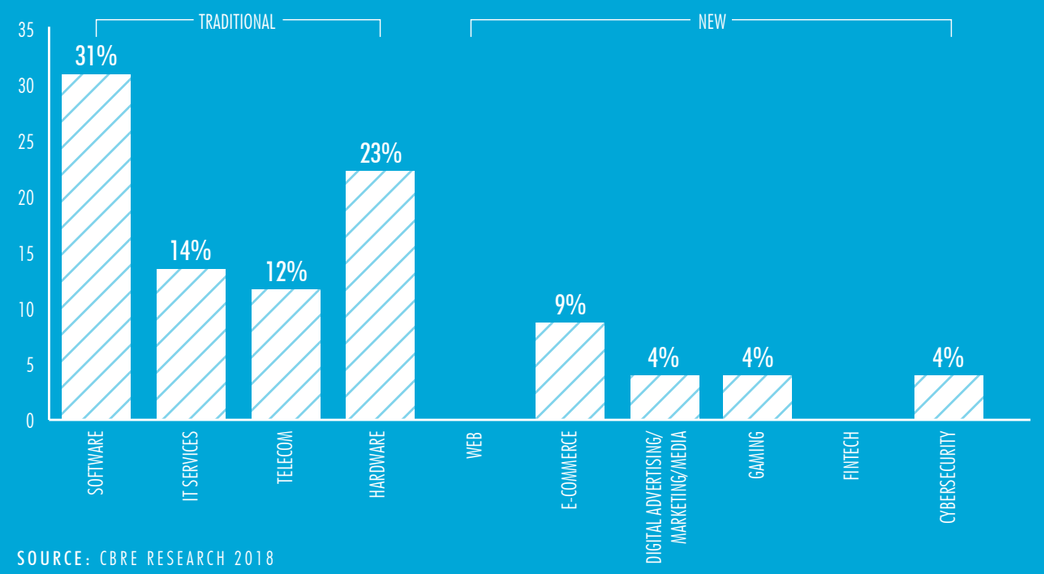
There is a difference in the size of company that software developers choose to work for within the Thames Valley with a far higher proportion of developers with under ten years' experience working for smaller organisations whilst those with more experience are drawn into the many multinational technology companies based in the region.

Oracle, Cisco and Microsoft are major employers of development talent in the Thames Valley region with Visa and Sky also having large operations in the cluster. Waitrose also has a systems development centre located in Reading supporting its retail business.

EMEA TECH CITIES
OPPORTUNITIES IN TECHNOLOGY HOTSPOTS

FIGURE 17: THAMES VALLEY TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

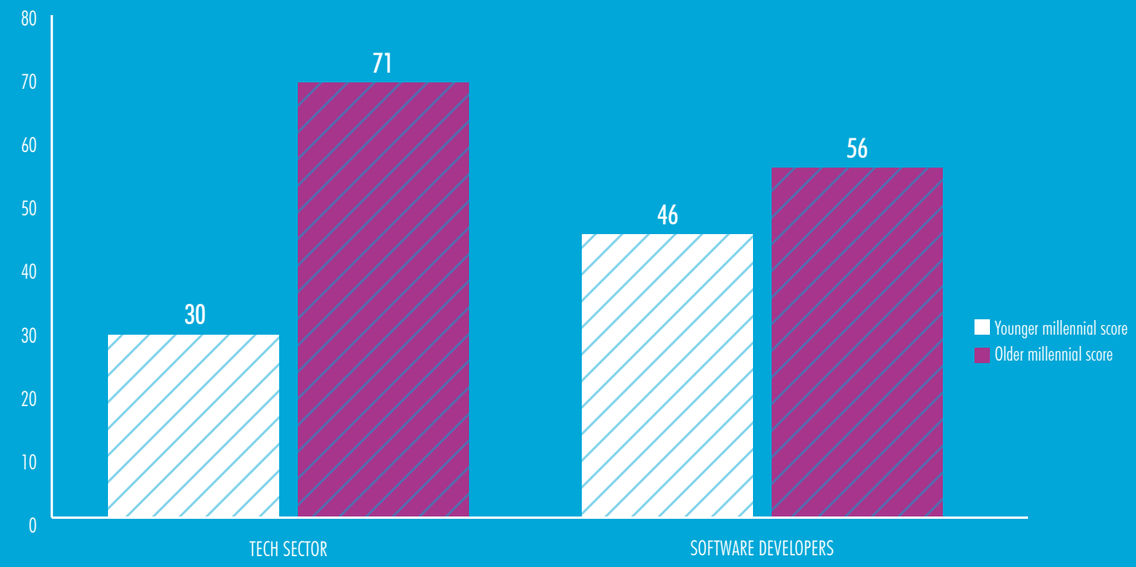
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 18: THAMES VALLEY EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

PRAGUE

Prague is one of the largest tech clusters in CEE with the tech sector growing by 25% since 2008 and with sector employment concentration almost three times the EU average. The demographic of the Prague tech sector is dominated by professionals with more than ten years' experience, contrasting other technology centres in CEE where the sector is typically dominated by those with less than ten years' experience.

Prague's tech sector demonstrates characteristics that are more aligned with Western European tech clusters in terms of its workforce being more experienced, but the city is also less dominated by very large international companies as found in Krakow and Bucharest.

Telecoms makes up a significant proportion of the tech employment in Prague with the largest companies based in the city including O2, T-Mobile and Vodafone. The IT services and software sub-sectors are also major employers in the city with companies including Hewlett Packard Enterprise, Trask Solutions, Oracle, Microsoft, SAP, and CA Technologies all having significant operations within the city. Logistics provider DHL also have a major IT shared service centre in the city.

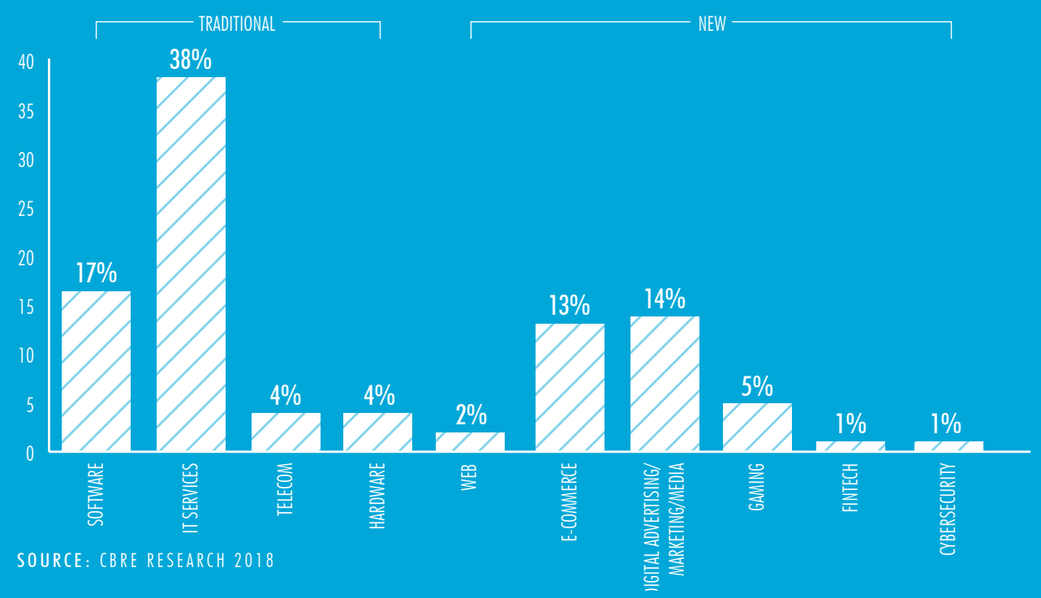
When looking at software development as a cross-sectoral activity, the demographic makeup of Prague's software development community also tends to be dominated by older millennials with more than ten years' experience. This is unusual as software development tends to be an industry with a younger employee profile across Western, CEE technology clusters.

Software development professionals in Prague are far more likely to work for SMEs rather than very large enterprises which tend to dominate the tech sector in the city.

The largest employer of software development talent in Prague is US based CA Technologies. Other major software development employers included STRV, NCR Corporation, Microsoft and Infor. A number of banking groups employ development teams including Barclays, Deutsche Börse as well as local companies Česká spořitelna and Komerční banka. With a major global shortage of cyber-security talent, the specialist company Avast Software has a significant development operation in Prague, which is its headquarters.

FIGURE 19: PRAGUE TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

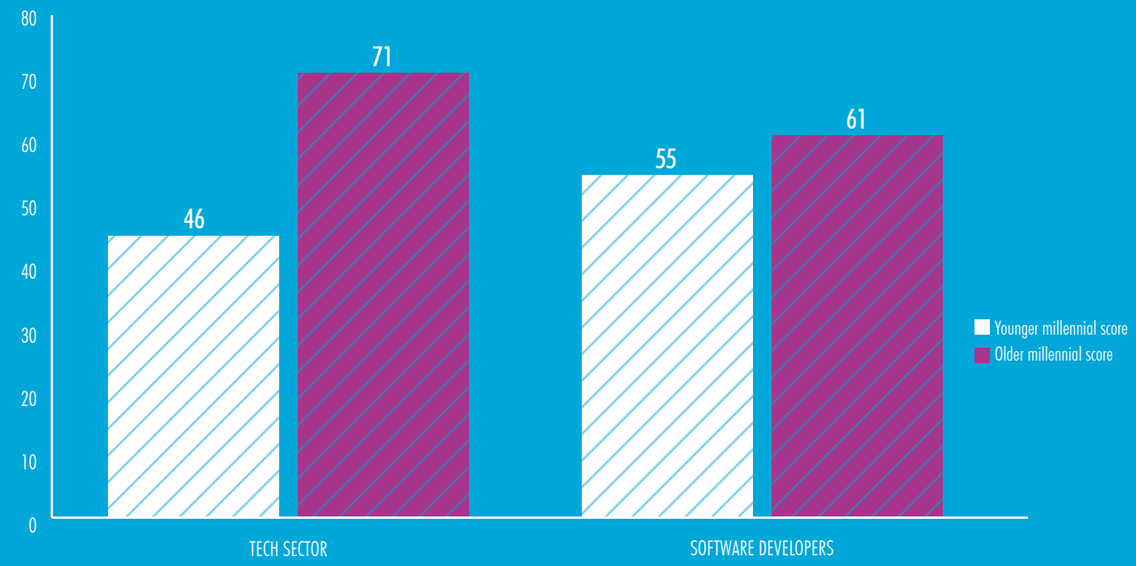
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 20: PRAGUE EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

BRISTOL

Bristol is one of the major regional centres for tech outside of London and the Thames Valley with employment in the sector growing by 25% since 2008 and with a location quotient significantly above the EU average for the sector. The demographic of the traditional tech sector is heavily dominated by older millennials with more than ten years' experience than those with under ten years' experience at 60% and 40% respectively.

Bristol is a major centre for the telecoms industry which are amongst the largest employers in the city with EE, BT, Nokia, Orange and Vodafone all having a presence in the city. Other major employers of tech talent include Lloyds Banking Group, IBM and Hewlett Packard Enterprise. Bristol is also home to IT service companies Softcat plc and Civica.

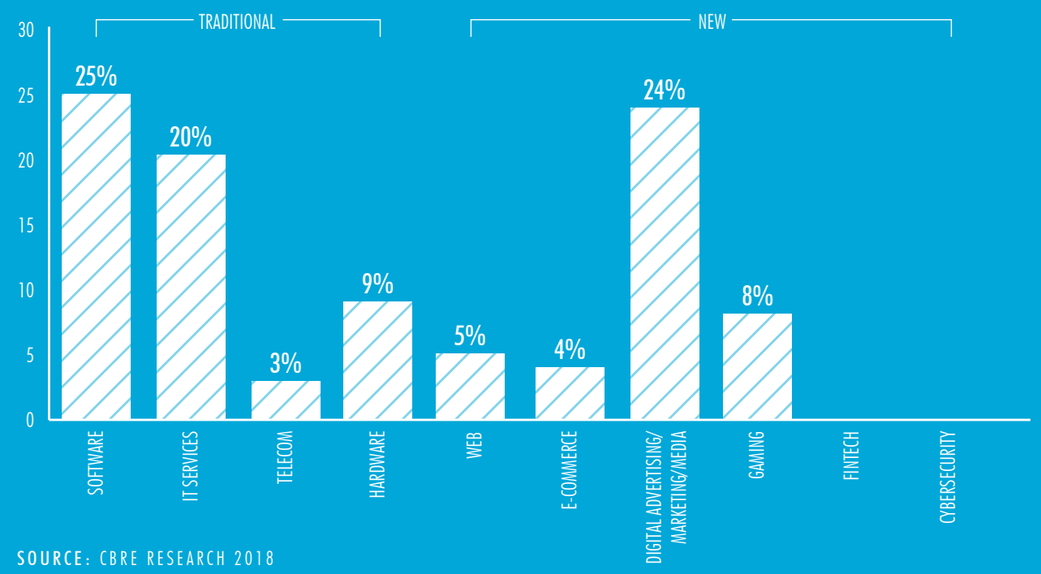
Bristol has emerged as a centre for software development and engineering talent. Its strong universities and vibrant urban environment have made Bristol a magnet for young development talent as evidenced by the software development activities being dominated by younger millennial talent with scores of 56 for younger millennials with under ten years' experience and 44 for older millennials with more than ten years' experience.

Bristol's software development employment is far less dominated by large companies than the traditional tech sector with a number of smaller start-ups and fintech companies sitting alongside more established telecoms and IT services companies.

Bristol has a thriving fintech scene spearheaded by Sword Apak and Hargreaves Lansdown, both of which were founded in Bristol and are experiencing significant international growth. Other fintech occupiers include Gresham Tech, and Smartstream Technologies which both have a significant presence in the city. Other companies which have software development hubs in Bristol include the online food ordering service JustEat and IT service company SciSys.

FIGURE 21: BRISTOL TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

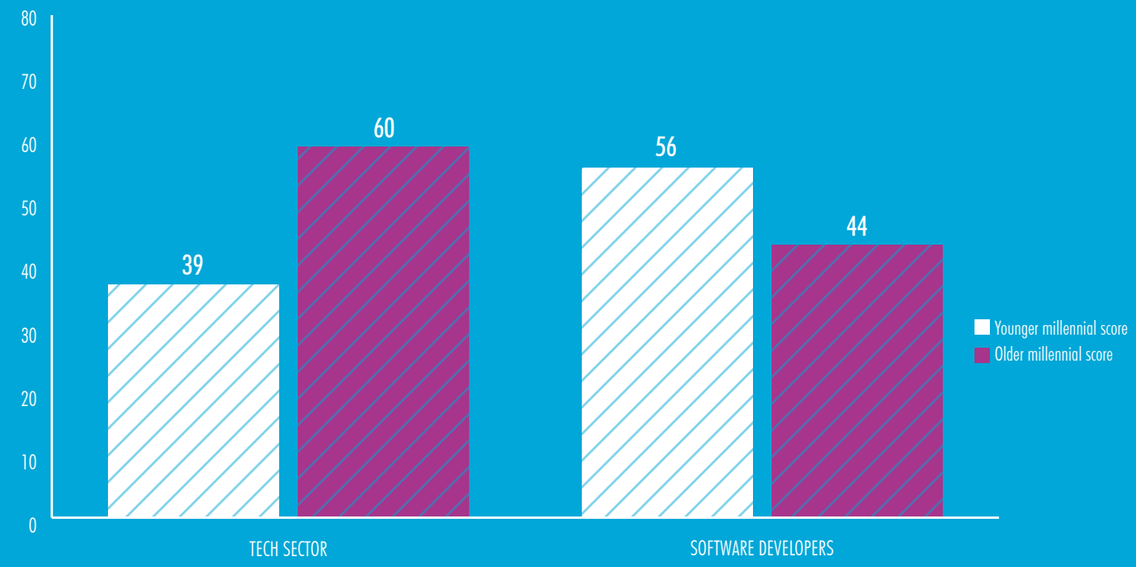
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 22: BRISTOL EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

NORMAL CLUSTERS

OSLO

Oslo is one of the premier tech hubs of Northern Europe with close to 50,000 employed in the sector. The city has experienced growth in employment since 2008 of almost 25% and its Location Quotient of 1.85 puts it towards the top of the Normal cluster category. The tech labour market in Oslo is dominated by those with more than ten years' experience and the experience level is broadly the same as the Thames Valley region of the UK.

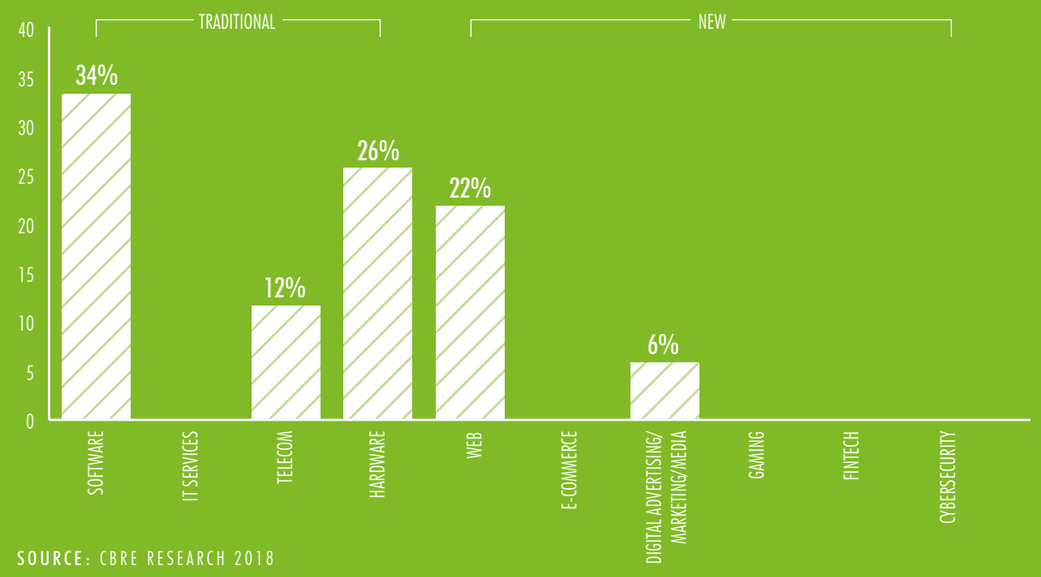
The most dominant sub-sectors of the Oslo tech sector are telecoms and IT services. The largest employers within the telecoms sector include Telenor and Telia Norge. The largest IT services employers in the city include Sopra Steria, Visma, IBM, and EVRY.

The trend across the Normal Cluster of cities is that software professionals tend to have a younger and less experienced profile compared to the broader tech sector but in Oslo those employed in software development are only very marginally less experienced.

The largest sub-sectors employing software development talent in Oslo are IT services, banking and telecoms. Large IT services employers of software talent include Tata Consultancy Services, Capgemini and Sopra Steria. The two largest development employers in Banking are Oslo-based Nordea and DNB. In the telecoms sector Cisco have a major innovation centre located in Lysaker, Oslo with more than 400 engineers.

FIGURE 23: OLSO TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

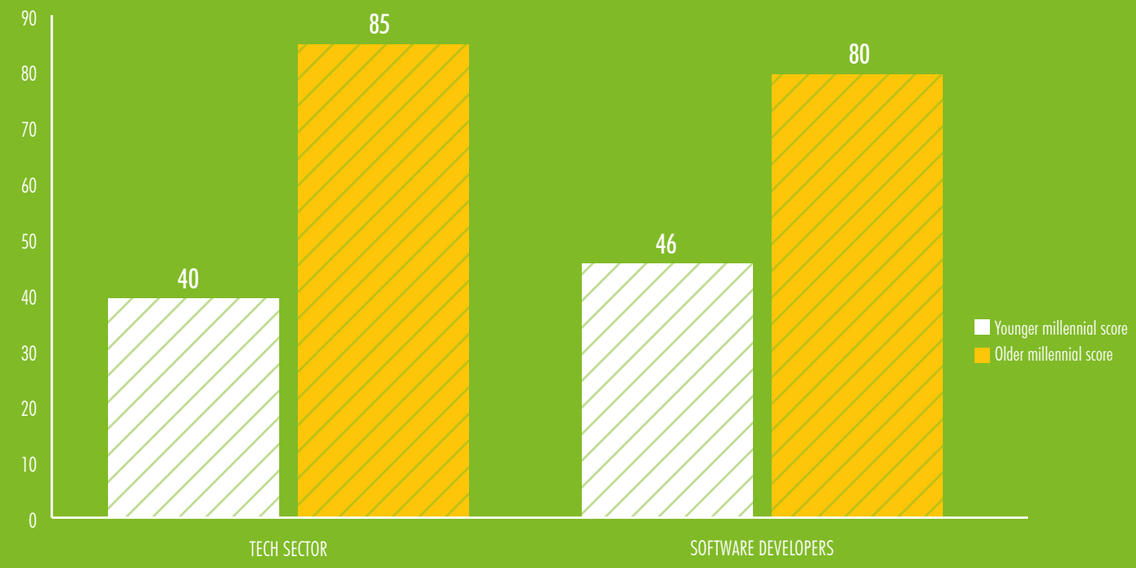
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 24: OSLO EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

HAMBURG

Growth in the tech sector in Hamburg has decreased since 2008 by 4%. However, it remains an extremely concentrated sector in the city with employment concentration levels in tech 65% higher than the EU average. The level of experience in the labour market in the tech sector in Hamburg is broadly in line with other major Western European technology centres, with more experienced employees dominating the labour market.

Hamburg is a centre of innovation in tech and has a thriving start-up scene. The city was the launchpad for two major German tech success stories with taxi hailing app MyTaxi and professional networking site Xing both headquartered in the city. Although not originally a tech company, online retailer Otto Group has undergone a complete digital transformation in the past decade to become a major force in the e-commerce industry and is headquartered in Hamburg.

Hamburg is regularly ranked as one of the top three cities with regard to its start-up environment. The start-up ecosystem in the city is benefitting from a steady influx of talent, a strong venture capital base and a range of corporates investing in new business models. Aside from the gaming industry, e-commerce, media and software, Hamburg also has an emerging fintech scene.

Where employment in Growth and Scale cluster cities tends to be dominated by large US companies, Hamburg's largest employers in the tech sector feature many German companies. Transport giants Lufthansa have a major tech operation in the city as do software giant SAP. Telecoms companies Deutsche Telekom (T-Mobile), QSC AG and Telefonica are amongst the largest employers in Hamburg. IBM, Microsoft, Adobe and Capgemini also feature amongst the largest tech employers in the city.

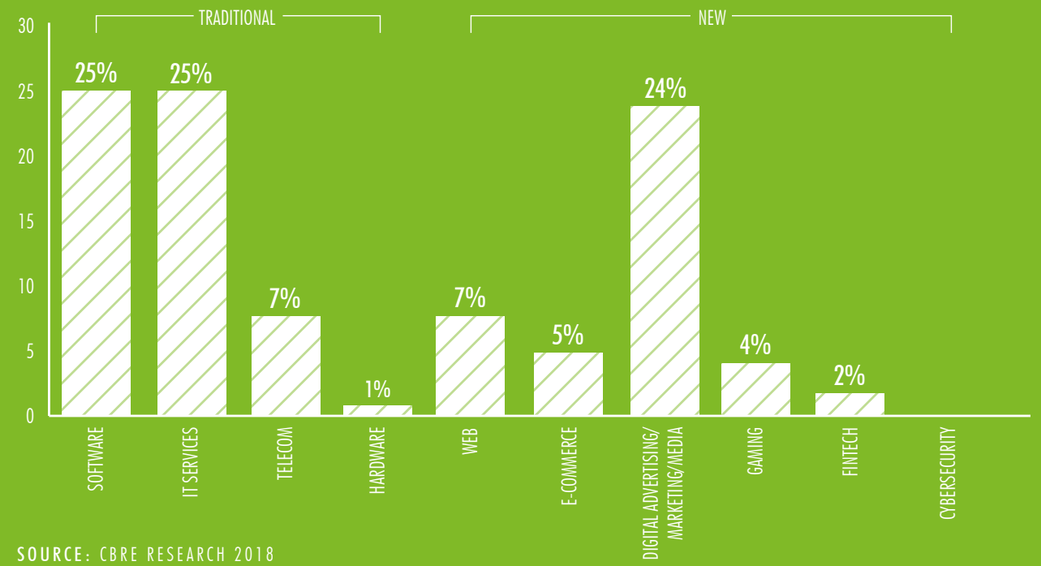
The experience level of Hamburg's software development talent is less dominated by those with more than ten years' experience compared to its overall tech sector. Just over half of those employed in software development are millennials with under ten years' experience.

As with the wider tech sector, Hamburg has a strong mix of smaller technology firms as major employers of software development talent. Digital marketing experts SinnerSchrader are amongst the largest employers of developers and were founded in Hamburg.

Hamburg has a thriving gaming scene with major companies founded and based in the city including InnoGames, Goodgame Studios and Bigpoint all featuring in the top ten largest employers of development talent. Engineering giants Airbus and Kuehne + Nagel also have software development teams in the city demonstrating the broad range of sectors that Hamburg supports.

FIGURE 25: HAMBURG TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

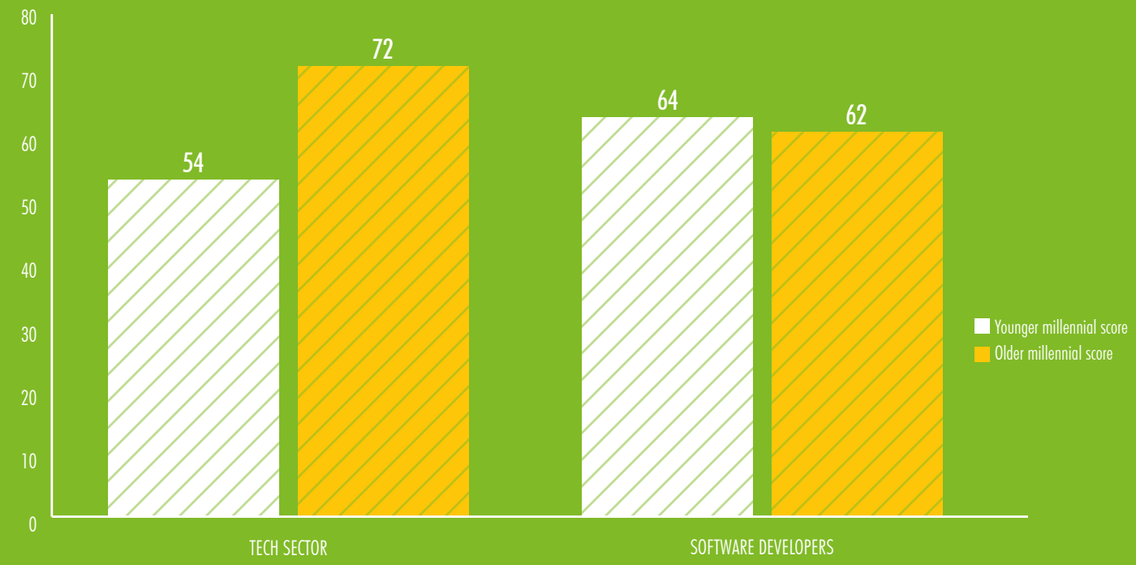
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 26: HAMBURG EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

TALLINN

Tallinn's tech sector is broadly in line with other Northern European capital cities with half of employment being within very large organisations. The demographic of the tech labour force is marginally weighted towards those millennials with under ten years' experience.

Tallinn is the city in which SMEs have the highest dominance of total employment of its tech sector. Across all experience levels, more than 50% of employment is within companies of this size. By contrast, the more established CEE markets of Krakow and Bucharest are dominated by very large organisations, suggesting that Tallinn is a centre for technology innovation and a strong start-up environment.

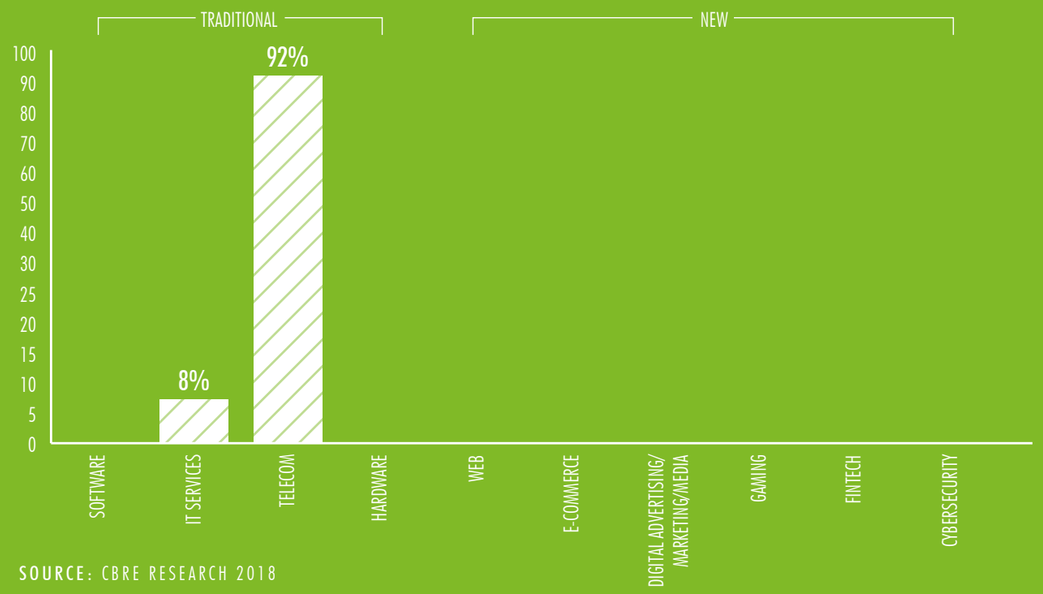
Tallinn is dominated by a number of indigenous tech companies focusing on IT services, telecoms and software including Nortal, Telia Eesti, Pipedrive, Helmes AS and the taxi-hailing company Taxify, which are all headquartered in the city and serve global customers. Tallinn's status as the launchpad for so many successful companies and its heavy focus on SMEs suggest that the city is a major centre for technology innovation.

When looking at software development as an activity, the demographic of the workforce is dominated by millennials with less than ten years' experience. The dominance of SMEs is even more pronounced when looking at which size of company employ development talent. Across all experience profiles, over 54% of employment is within this size of company. Just 30% of Tallinn's software developers work for very large organisations.

The major employers of development talent are also notable for the dominance of local Estonian companies who have launched from the city. Software companies including Icefire and Mooncascade are both headquartered in Tallinn, and Fintech company Transferwise which is based in London but was founded by two Tallinn-born entrepreneurs is a major employer of development talent in Tallinn. The gaming company Playtech is also a major employer of development talent in the city.

FIGURE 27: TALLINN TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

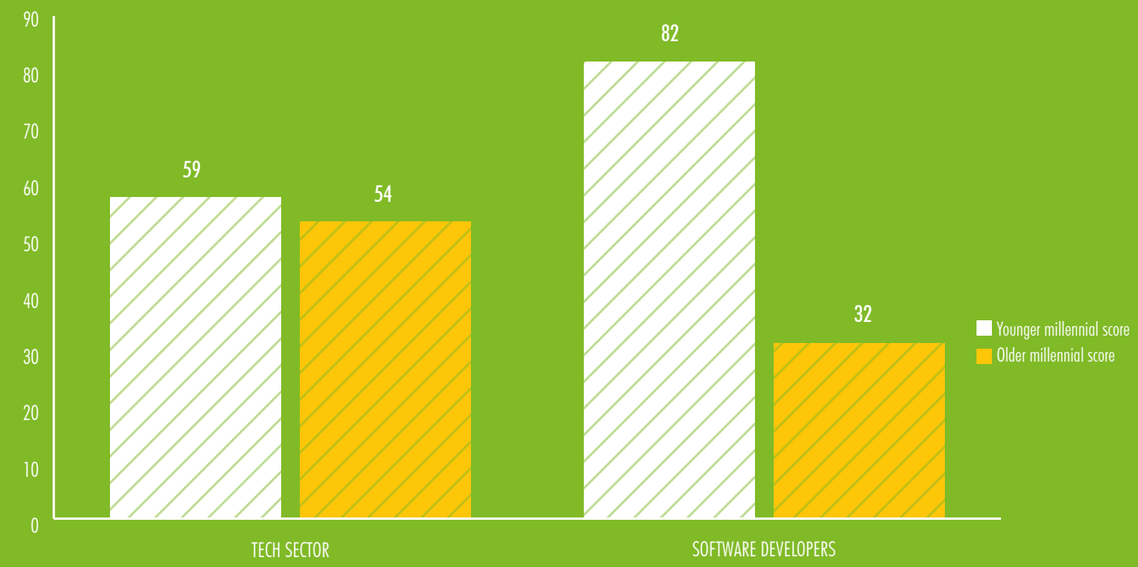
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 28: TALLINN EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

GROWTH CLUSTERS

KRAKOW

Krakow is in line with the trends observed in other Growth Cluster cities in that the experience profile of its talent pool is dominated by those employees with less experience. 27% of the tech workforce have less than five years' experience rising to 35% who have between five and ten years' experience and 38% who have more than ten years' experience. The huge growth in tech employment since 2008 (66%) is the primary reason that the current tech talent pool in Krakow is dominated by those with less experience.

As in other CEE tech centres, employment in the Krakow tech sector is significantly dominated by very large organisations. This is a result of Krakow's success in attracting nearshore and offshore investments from major international technology companies drawn in by its deep talent pool and competitive labour costs.

Software and IT services make up over half of the total employment in Krakow's tech sector, the largest players in the market being Comarch, Capgemini, Sabre Corporation and Luxoft.

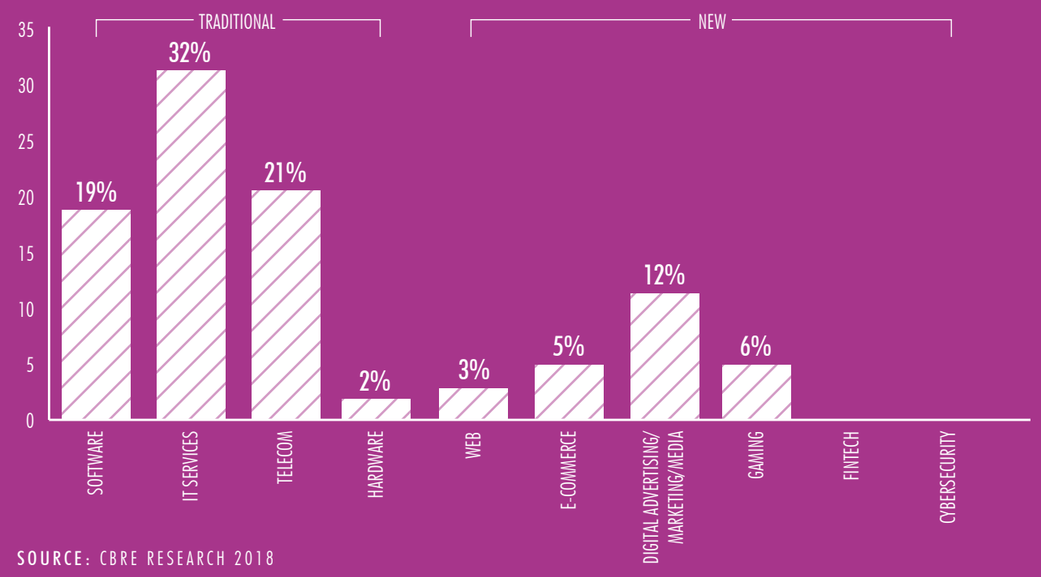
Krakow's software development employment is even more dominated by less experienced developers with just 18% having more than ten years' experience. 37% and 44% have under five years' and between five and ten years' experience respectively reflecting the relatively recent emergence of Krakow as a major hub of software development.

As with the overall tech sector, Krakow's software development workforce is also largely employed by very large companies with more than half of all employment being with this size of company across all experience levels.

Telecoms, software and IT service sectors dominate the list of largest employers in Krakow with major players including Ericsson, Motorola, EPAM Systems and Sabre Corporation. Telecoms companies dominate the employment of employees with under ten years' experience. Due to the competitive nature of the Krakow labour market, it is not uncommon for technology companies to offer benefits including uncapped annual leave, generous training budgets and on-site fitness and wellness coaches in order to attract the top talent.

FIGURE 29: KRAKOW TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

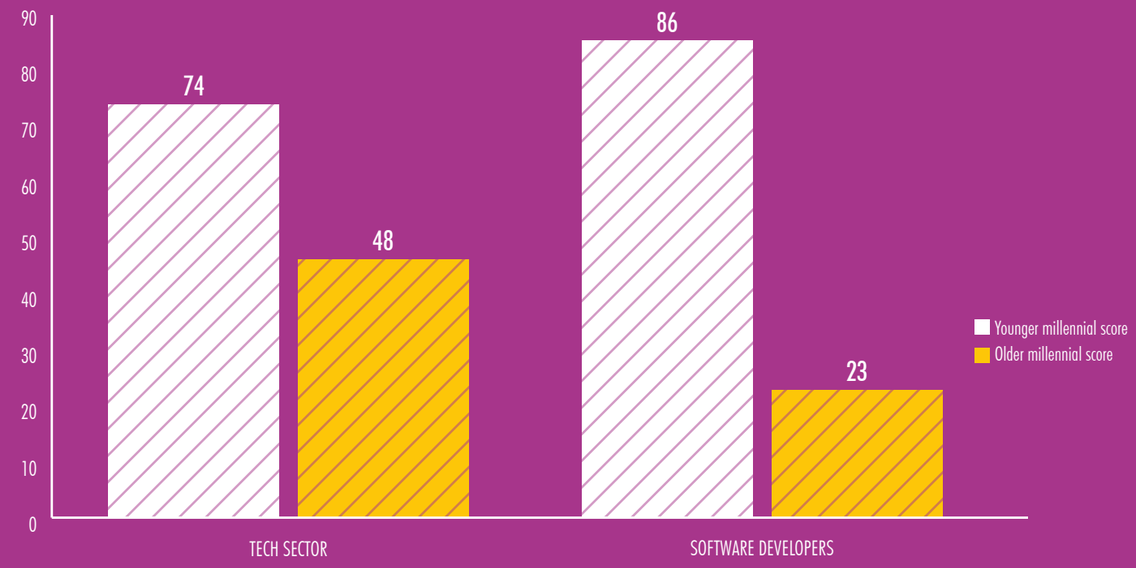
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 30: KRAKOW EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

POZNAN

Poznan's overall tech sector follows the trend of other Growth Cluster cities in that its workforce is far more heavily dominated by younger millennials with less than ten years' experience. This is likely to be as a result of the huge levels of investment in the city over the past decade with tech employment growing by 64% since 2008.

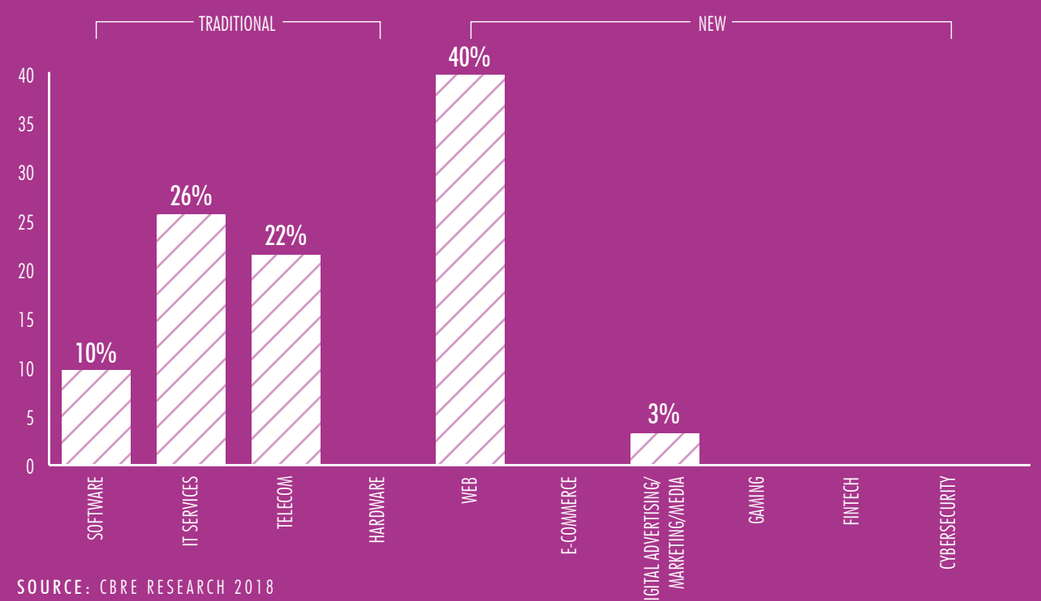
In addition to having a younger employee profile than the more established European tech clusters, Poznan has been the successful launch pad for a number of successful companies which were founded in the city: Netguru a software and solution development consultancy founded in Poznan in 2008; Talex, a data centre service provider based in Poznan; INEA, an online retailer of telecoms and TV systems of homes and businesses founded in Poznan; Allegro the largest online retailer in Poland founded in Poznan in 1999; and Komputronik an online retailer of electrical products founded in Poznan in 1996. The success of these organisations and their roots in the city demonstrate the entrepreneurial spirit and talent in the city.

Poznan's software development employment is also dominated by a less experienced workforce, the city's employment in this area being largely made up of millennials with less than ten years' experience.

The entrepreneurial home-grown trend continues when we look at software development as an activity with a number of the largest employers being indigenous Polish companies. PSI Polska are a major employer of development talent and provide software solutions for the utilities, energy and transport industries; Sii Poland are one of the largest providers of IT and engineering services in Poland and have a major development operation in Poznan. Large international employers of developer talent in the city include Capgemini, Cognifide and Roche.

FIGURE 31: POZNAN TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

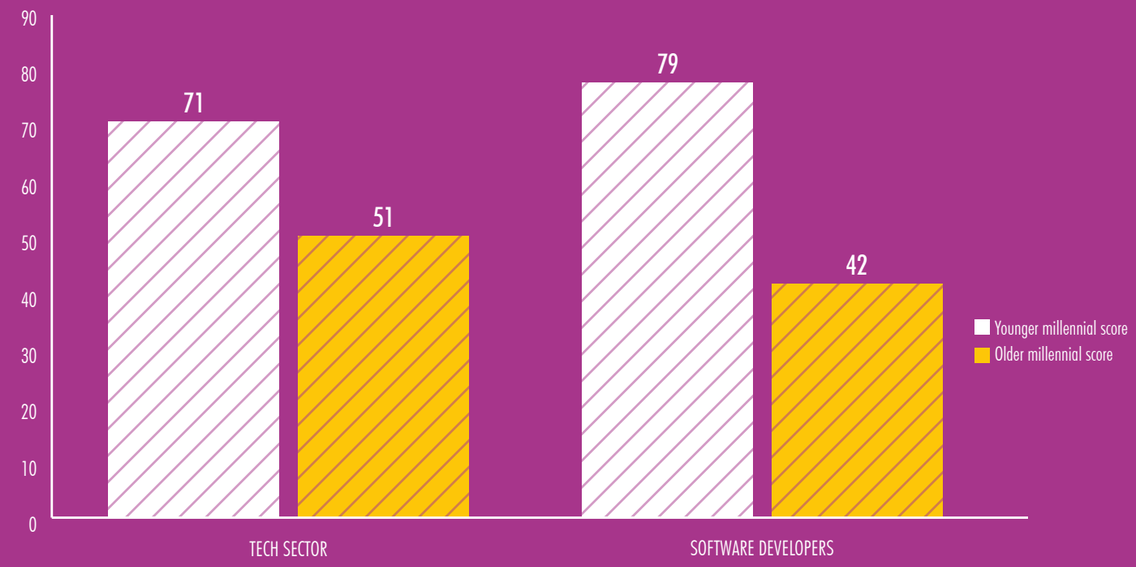
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 32: POZNAN EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

VILNIUS

Vilnius has become one of the primary technology centres in the Baltic region. The city is a centre for banking technology with Barclays, Danske Bank and Swedbank having significant operations in the city. Although the city has a location quotient below the EU average, employment in the tech sector has grown by 18% since 2008. A well-educated workforce and multilingual capability has made Vilnius a major destination for investments from the Nordic region.

The Vilnius tech sector is less dominated by very large organisations compared to other IT hubs in CEE. Just 33% of employment in the tech sector is with very large companies. The experience level of employees within the tech sector is more focussed on younger millennials with less than ten years' experience, with this cohort making up 61% of the employment in contrast with major Western European tech hubs which are more dominated by those with over ten years' experience.

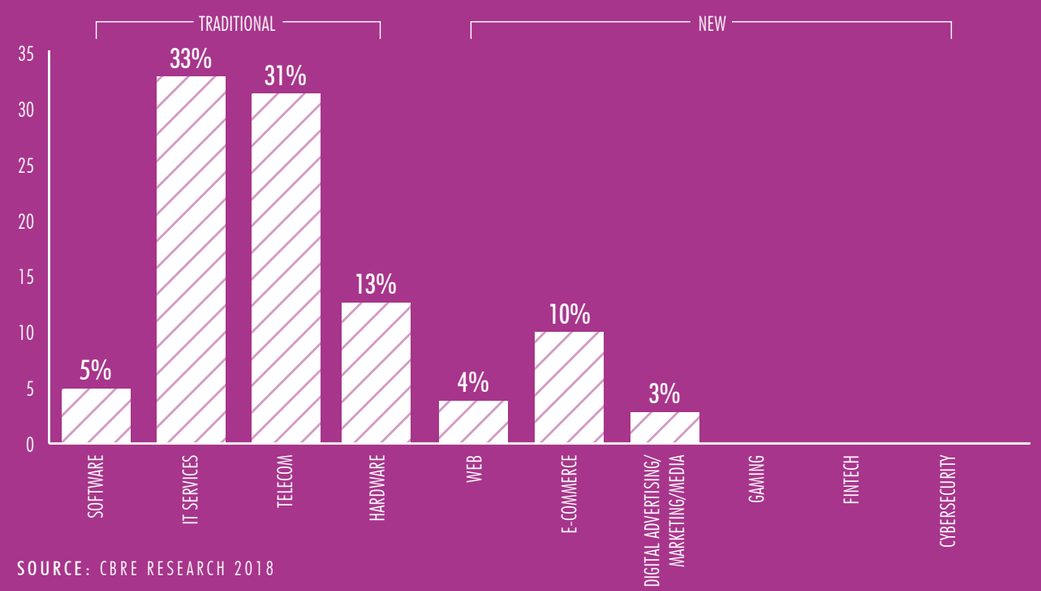
In addition to its financial service pedigree, Vilnius also has a large presence of telecoms and IT services companies with Telia Lietuva, IBM, DXC Technology having a large presence in the city. Vilnius is also home to Teltonika, a technology company focussed on the Internet of Things with a particular focus on fleet management.

When analysing the software development sector in Vilnius there are a number of innovative companies with a presence in the city. UK-based infrastructure technology company Bentley Systems has a large software development hub in the city. Another company taking advantage of Vilnius' depth of development and engineering talent is US-based Devbridge who have a large presence in the city. The experience level of Vilnius' software professionals is even more dominated by younger millennial talent with this group making up 68% of the software employment.

In addition to the local software development companies such as Baltic Amadeus; Tel Aviv based cloud development experts Wix have a software development centre in Vilnius. A number of Nordic companies are taking advantage of Vilnius' expertise in software development including Adform, SEB Bankas and Visma.

FIGURE 33: VILNIUS TECHNOLOGY LEASING SUB-SECTOR MIX (2016-17)

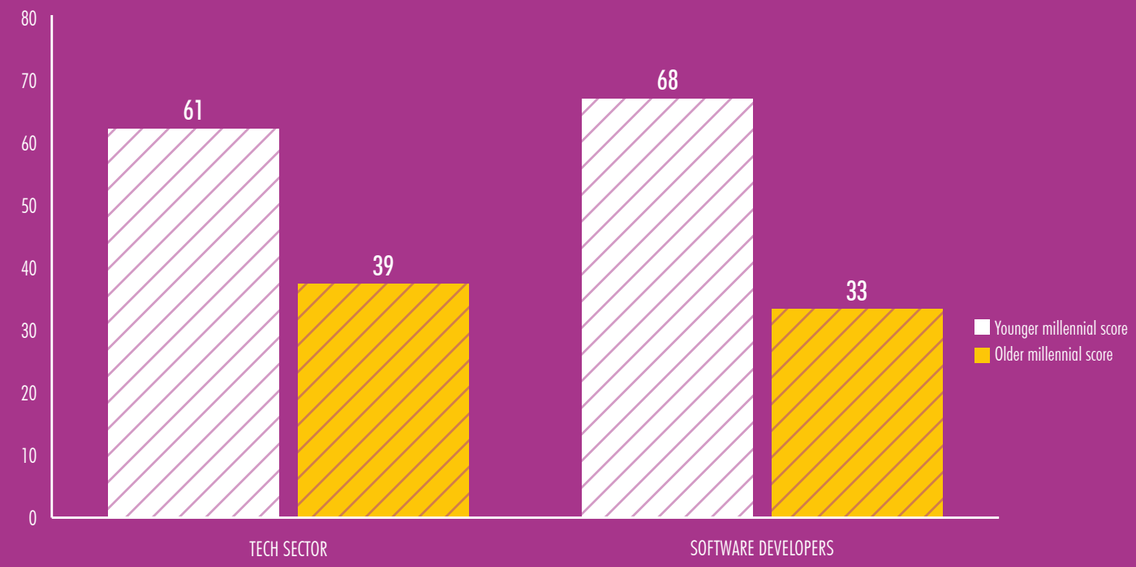
Sub-sector mix of tech leasing deals (%)



SOURCE: CBRE RESEARCH 2018

FIGURE 34: VILNIUS EXPERIENCE SCORES

Experience score of millennials working in the tech sector and of millennial software developers



SOURCE: CBRE RESEARCH, LINKEDIN 2018

APPENDIX

FULL LIST OF DATA METRICS

CBRE

- Leasing data for full year 2016 and 2017

Eurostat (for all European NUTS 2 regions)

- Total employment, high tech sector employment, high tech manufacturing employment, knowledge intensive services employment, percentage of 30-34-year olds in employment with tertiary education, population of 25-29 year olds, population of 30-34 year olds, gross value added, GDP per capita, SBS Information and Communication (consisting of: Publishing activities, motion picture, video and television programme production, sound recording and music publishing activities, programming and broadcasting activities, computer programming, consultancy and related activities, information service activities) employment, number of local units, wages and salaries, and number of persons employed.

Oxford Economics

- Forecast technology employment

LinkedIn

- Number of persons employed (and their experience) in technology sector and number of software developers employed, by city and cluster type.

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RANKING FACTORS

The following are the list of weighting factors used to determine the ranking of cities within the four cluster types:

SCALE CLUSTERS

- High tech employment: 30%
- High tech employment location quotient: 14%
- High tech employment percentage change: 14%
- High tech employment as a percentage of total employment: 14%
- Knowledge intensive services employment percentage change: 14%
- Tech GVA: 14%

SUPER CLUSTERS

- High tech employment: 10%
- High tech employment location quotient: 10%
- High tech employment percentage change: 10%
- High tech employment as a percentage of total employment: 10%
- Knowledge intensive services employment percentage change: 10%
- Percentage of 30-34-year olds in employment with tertiary education: 10%
- Population of 30-34-year olds location quotient: 10%
- Population of 30-34-year olds percentage change: 10%
- Tech GVA: 10%
- Forecast technology employment: 10%

NORMAL CLUSTERS

- High tech employment: 20%
- High tech employment location quotient: 20%
- High tech employment percentage change: 8%
- High tech employment as a percentage of total employment: 8%
- Knowledge intensive services employment percentage change: 8%
- Percentage of 30-34-year olds in employment with tertiary education: 8%
- Population of 30-34-year olds location quotient: 8%
- Population of 30-34-year olds percentage change: 8%
- Tech GVA: 8%
- Forecast technology employment: 8%

GROWTH CLUSTERS

- High tech employment percentage change: 20%
- Population of 30-34-year olds percentage change: 20%
- Population of 25-29-year olds percentage change: 13%
- Forecast technology employment: 20%
- Tech GVA: 13%
- Computer programming, consultancy and related activities employment as percentage of technology employment: 13%

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