

AMPLIFY

IACW Innovation Commission Global, EU and UK Innovation Comparators

A report for the Innovation Advisory Council for Wales

March 2021

Contents

Overview of Amplyfi	2
About AMPLYFI Analysis Methodology	3
IACW Innovation Commission Global, EU and UK Innovation Comparators	4
Section 1: Global Trends Within the Innovation Sphere	4
Section 1.1: Technological Innovation	4
Section 1.2: Social Innovation	8
Section 1.3: Public Sector Innovation	10
Section 1.4: Drivers of Innovation	12
Section 2: A Comparison of World-Leading Innovation Centres	15
Section 3: Case Study - How has Ireland, and in Particular Dublin, Fostered Innovation	20
Section 3.1: Ireland's links to Innovation	20
Section 3.2: Exploring Ireland's Patent Landscape	23
Section 4: Case Study - How has the e-Estonia Programme Affected Innovation	27
Section 5: Case Study - Manchester as a Centre for Innovation	31
Supplementary Materials	35
How to Interpret AMPLYFI Graphs	35
Word Clouds	35
Topic Landscape	36
References	37

Overview of Amplyfi

Businesses survive on the quality, depth, and speed of information. But there is a problem: the advent of the internet has made data fragmented, hard to find and almost impossible to interpret.

Amplyfi was founded in 2015 by Chris Ganje and Ian Jones after they worked together at BP on global strategic projects. They experienced first-hand the difficulties in obtaining objective insight from traditional structured data and expert opinions from a relatively small group of people that competitors were also using. They decided artificial intelligence, the internet and unstructured data held the key, so they set about building a team of pioneering technologists, academics and sector experts to make their vision a reality.

Amplyfi has developed a comprehensive business intelligence platform that unlocks the power of the deep web. Our technology delivers unique insights by connecting structured and unstructured data at scale to uncover previously hidden links, trends and opportunities.

Amplyfi is revolutionising business intelligence.

About AMPLYFI Analysis Methodology

This report will include insight derived directly from AMPLYFI's technology suite, alongside analyst commentary and complementary evidence from external sources where appropriate.

For this research, AMPLYFI ingested and analysed over 60,000 English language documents from across the globe that discuss innovation. The same task has an equivalent human-read time of 11 years.

During AMPLYFI analysis key topics across the document corpus are identified and arranged into groups that are linked by a common theme. Topics are identified using natural language processing and given a yearly significance score by a machine learning algorithm. For example, a topic would be a statistically significant key phrase such as 'Artificial Intelligence' or 'Internet of Things' which can then be grouped into a theme based around 'Technological Innovation'. For every year in which a given topic is relevant, a significance score is calculated to allow historical trends to be drawn out. On top of this, AMPLYFI is also able to highlight the strength of the connection between a topic and geographical locations, organisations and people.

A short guide on how to interpret some of AMPLYFI's outputs can be found in the Supplementary Materials Section

IACW Innovation Commission Global, EU and UK Innovation Comparators

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Section 1: Global Trends Within the Innovation Sphere

The first section of this report aims to give a high-level overview of AMPLYFI's analysis of global innovation. This analysis is fuelled by more than 60,000 documents that discuss innovation between 2015 and 2020. This overview will give the reader a general grounding in the global innovation landscape and paint a picture of overarching macro-trends.

Section 1.1: Technological Innovation

When hearing the word, "innovation", technological advancement is a common first thought which is reflected in these results. When considering the analysis as a whole, technological innovation is the most significant type of innovation with four of the top five most significant topics related directly to emerging technologies. Figure 1 shows the top-ten most significant technology innovations over the study period.

The most significant technology-related topic, by some margin, is Artificial Intelligence (AI) and in fact, this topic is the number-one most significant topic across any theme. A key attribute in our calculation of significance is the interconnectivity of a topic, and in the case of AI, it is connected to lots of other key areas. For instance, if we look at the key technology innovations in Figure 1, artificial intelligence is crucial to enabling the Internet of Things (IoT), Smart Cities, Autonomous Vehicles, Virtual Reality and unlocking the value stored in Big Data. As well as being linked to other emerging technologies, AI can be applied to innovate almost every industry making it a highly pervasive topic.

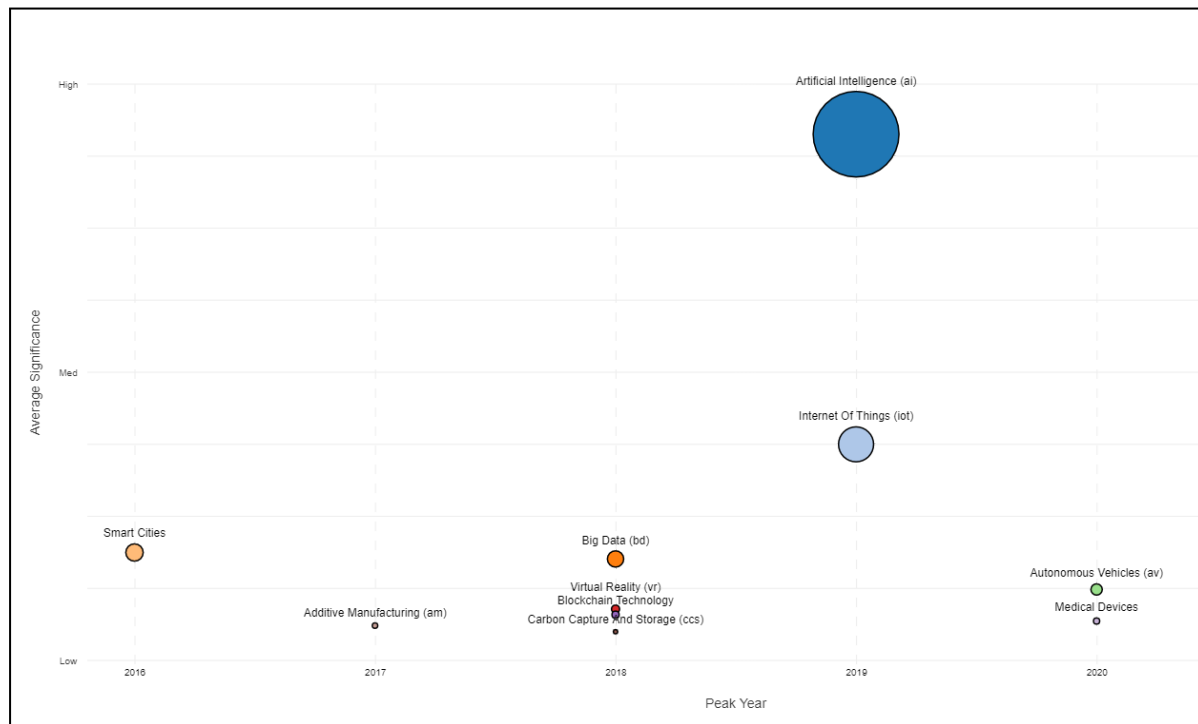


Figure 1 Technology landscape showing the average significance of the top-ten technological innovations

The Internet of Things has the second-highest average significance followed by Smart Cities, however, the latter experienced its peak significance early in the study period - in 2016. This means that its link to innovation has weakened relative to other topics over the six years of the study period, however, even at its weakened level, it is still a highly prominent topic.

Notable technological innovations in Figure 1 include Autonomous Vehicles and Medical Devices. These topics are not at the very top of the list in terms of average significance (although they are in the top-ten) but they do exhibit peak significance in 2020, the most recent year in the study. This suggests that both of these topics are on an upward trajectory and are more likely to show fast growth in the coming years.

If we consider the development of these top technological innovations, the most important enabler is funding. The fintech sector is extremely well funded and is able to drive innovation in the areas in which it sees value. Global fintech funding by venture capital firms alone was over \$100 billion in 2020.¹ At least three of the top-ten technologies (AI, Big Data and Blockchain) are heavily supported by fintech funding with this analysis showing a particularly strong link between fintech and the technologies of Blockchain and Big data. One of the reasons that the fintech sector has been so active

over the last six years, particularly in Europe, is due to a regulatory environment that has encouraged competition. It has now been over three years since PSD2 legislation brought Open Banking to Europe in January 2018.²



Figure 2 Word cloud showing the average significance of terms closely related to fintech innovation

Figure 2 shows a collection of topics that AMPLYFI's analysis highlighted having a strong link to fintech. In this graphic, the size of each word relates to the average significance of the topic in relation to the overall analysis of innovation and does not directly relate to the strength of its connection to fintech. This means that out of the topics related to fintech, the technology of Big Data is the most significant topic in terms of innovation.

Big data is important to the fintech sector as it is a widely held belief that better analysis of bigger datasets will lead to more successful outcomes, particularly in the investment and lending spaces.³ Blockchain technology (which is a type of Distributed Ledger Technology) is harnessed in the fintech space primarily as a means to regulate digital currencies and smart contracts. Whilst both of these technologies are benefiting from large amounts of fintech funding, it is interesting to note that non-fintech use cases of these innovations are also common. In this sense, innovations that are aligned technologically with that of fintech are benefiting from fintech dollars. The ability to leverage heavily invested innovation areas to benefit tangential causes is perhaps a potential strategy that could be employed by the Welsh government.

Non-fintech uses of Big Data analytics are evident in healthcare,⁴ manufacturing⁵ and the enablement of smart cities,⁶ whilst Blockchain technology is finding a variety of uses from supply chain management of cocoa beans⁷ to car-parts.⁸

The mobility sector is another important sector supporting innovation that is strongly represented in the analysis. Of the top-ten technology innovations in Figure 1, the mobility sector is closely related to three of them; Smart Cities, Autonomous Vehicles and Virtual Reality. Figure 3 shows the topics which are closely related to the mobility sector. In this graphic, the size of each word relates to the average significance of the topic in relation to the overall analysis of innovation and does not directly relate to the strength of its connection to fintech.

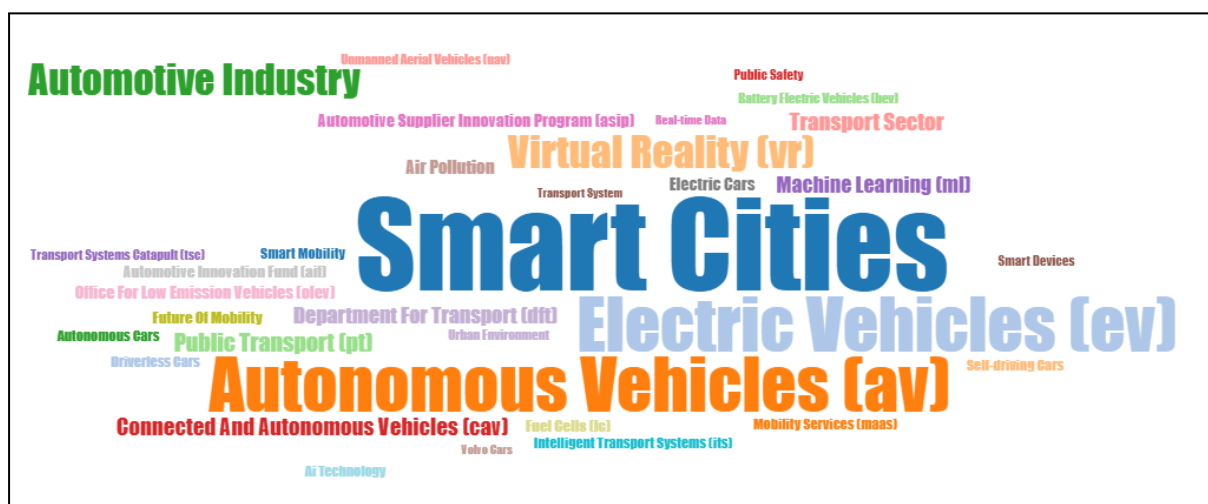


Figure 3 Word cloud showing the average significance of terms closely related to mobility innovation

The biggest innovation areas linked to mobility are Autonomous Vehicles, Electric Vehicles and Smart Cities. This piece of analysis clearly shows that mobility and smart cities are closely linked, with a particularly strong link between the topics of Autonomous Vehicles, Smart Cities, Smart Devices and Connected and Autonomous Vehicles.

There are several key organisations linked to the mobility sector that aims to increase innovation in this area. The most significant is Canada's Automotive Supplier Innovation Program which was part of a \$100 million action plan put in place in 2015⁹, with the ongoing success of Vancouver-based *Nano One* a highly publicised success story.^{10,11} Other significant innovation supporters recognised by AMPLYFI include the Automotive Innovation Fund, (another Canadian Government-backed scheme), and UK's Transport

System Catapult. Similar to the findings in this analysis, the UK government identified the connections between smart cities and mobility and in 2019 created a Connected Places Catapult which combined the work of the Transport System Catapult with that of the Future Cities Catapult.¹²

Section 1.2: Social Innovation

Social Innovation has been highlighted in this analysis as an important theme within the sphere of innovation. The phrase 'Social Innovation' manifests itself as a key topic, as well as a thematic thread of commonality that links a group of topics into a theme. As Figure 4 shows, a number of the most significant topics in this group have been exhibiting a general decline in significance throughout the study period. This decrease suggests that other innovation types, such as technological innovation, have been increasingly dominant in discussions surrounding innovation. A decrease in significance does not always mean that people are talking about the topic less frequently, however, it does suggest that its growth is slower than most topics in the corpus.

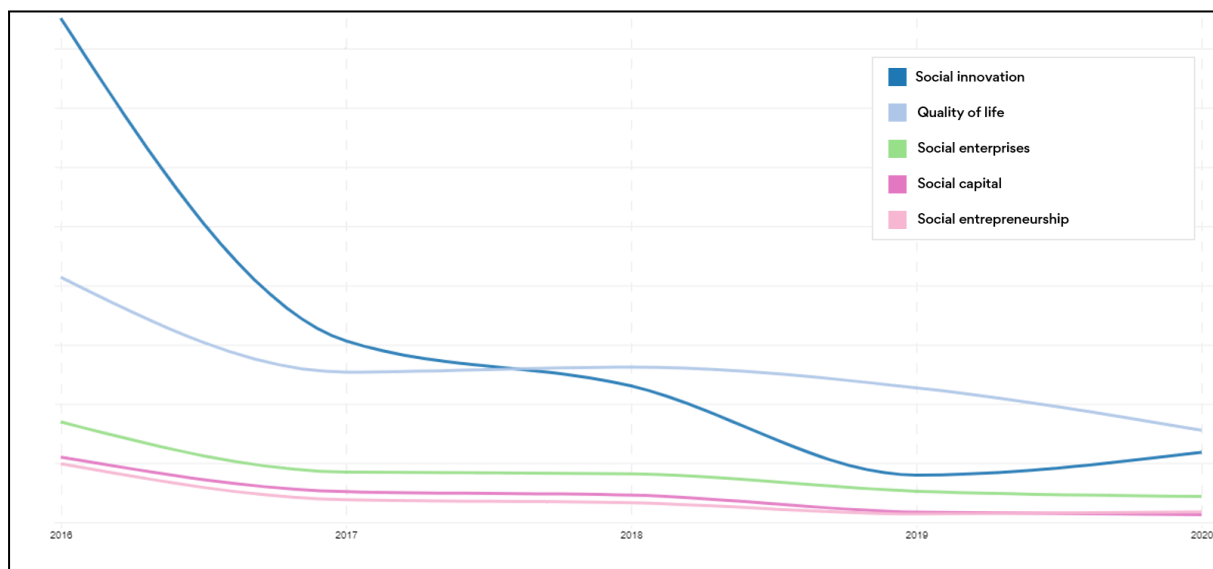


Figure 4 Line chart showing the decreasing significance of a number of topics related to Social Innovation

Topics showing a falling significance include Social Innovation, Social Enterprises, Social Capital and Social Entrepreneurship. It is worth noting that the topic of Social Innovation did show signs of an uptick in 2020, buoyed by its links to the UN's Sustainable Development Goals (SDG).

Regardless of the shifting significance of its topics, the theme of Social Innovation has a particularly strong link to Singapore. Some of the main drivers of this connection are caused by the Singaporean government's initiatives to foster innovation in this space. Two examples of this include VentureForGood Grants and Business for Good Internships. The Singapore Centre for Social Enterprise (raiSE) supports VentureForGood grants which allow social enterprises to apply for up to \$300,000 in grant funding.¹³ Business for Good Internships are supported by a partnership between DBS bank and Singapore Management University and give applicants the chance to complete internships alongside well-regarded social entrepreneurs.¹⁴

In general, we have evidenced a decrease in the significance of social innovation topics, however, there are a smaller number of related topics that are showing an uptick in significance in 2020, similar to that recognised for the Social Innovation topic in Figure 4.

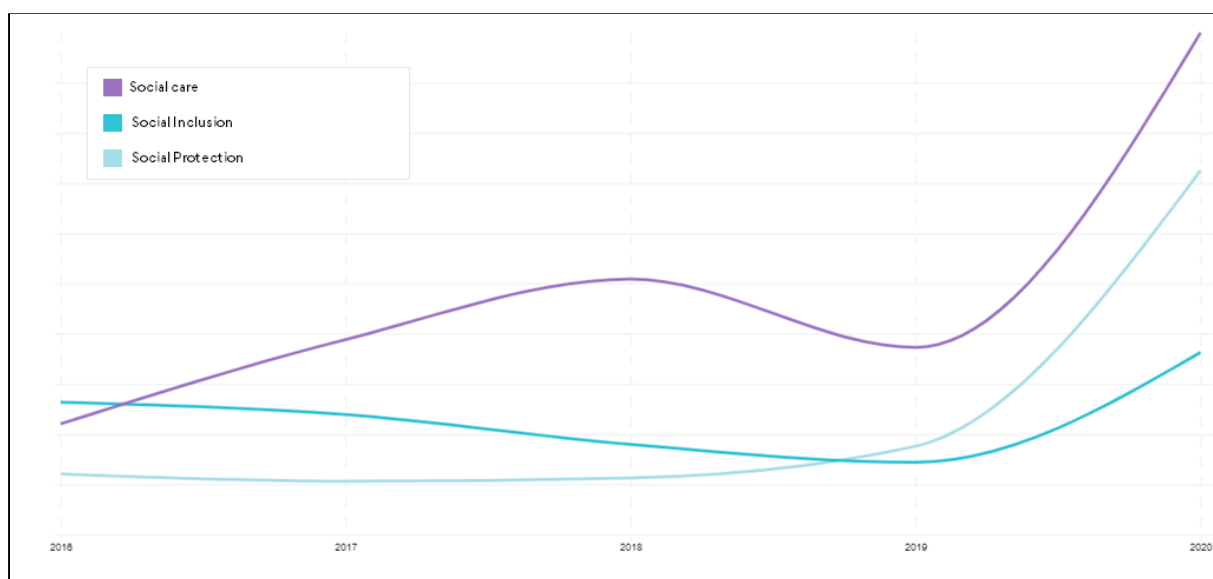


Figure 5 Line chart showing social topics with positive momentum

Figure 5 shows that the topics Social Care, Social Inclusion and Social Protection are all showing some positive momentum in 2020. The driving force behind the increased attention of Social Care and Social Protection innovations in 2020 is due to their links to the COVID-19 pandemic. A good example of this link can be evidenced by how NHS Digital, the body responsible for data and IT systems for the health service in England, was able to supply NHS Mail applications to the social care sector during the early stages of the pandemic when stay at home orders were in place. On the back of this move, the body will now further innovate the sector by helping to centralise the

dispersed landscape of social care data to offer more powerful analytics.¹⁵ The question remains as to whether this momentum in the sector will be maintained post-COVID.

Similarly to the topic of Social Innovation (Figure 4), the topic of Social Inclusion showed peak significance in 2020 due to its links to UN Sustainable Development Goals (SDG). Social Inclusion is called out as a specific target as part of SDG number ten, 'Reduce inequality within and among countries'.¹⁶ Social innovation topics are becoming increasingly significant in this context, due to work conducted by organisations such as the Basel Institute of Commons and Economics. They argue that Social Inclusion has previously been 'left behind' by the goals.¹⁷

There is a stark difference between the results linked to technological innovations in the fintech sector, and those aligned to social innovation. The cash-rich fintech sector has funding available to drive innovation, and push the boundaries of what is possible. In some cases this innovation occurs before anyone has a use for it. The key driver behind social innovation seems to be necessity, be it a global pandemic or stifling global inequality too large to ignore.

Section 1.3: Public Sector Innovation

Due to the size, complexity and funding structure of public sector organisations, innovation is typically expected to be slower than within private organisations. A common way to combat this lag is for the public sector to form partnerships or fund private sector initiatives. Figure 6 shows the overall significance of topics that are related to public sector innovation. The topic Public-Private Partnerships (PPP) is a key contributor, with a significance second to only that of Local Authorities.



Figure 6 Word cloud showing the average significance of topics closely related to public sector innovation

Looking closely at the topic of PPPs reveals a strong connection to Israel, a nation that has a successful track record in using PPPs to foster innovation. A great example of this success is with Yozma, a venture capital (VC) fund initially set up in the 1990s that is credited with catalysing Israel's modern-day, burgeoning VC landscape.¹⁸ By pumping public money into jointly funded VCs, Israel was able to attract private investment by sharing the downside risk. Currently, within Wales, the Development Bank of Wales (DBW) has the role most comparable to that of Yozma, however, the DBW seems to have less of a focus on forging public-private partnerships and values its role as a business enabler through the investment of its funds.

A second highly active and highly successful public-private partnership in Israel is the Technological Incubators Program, run by the Israel Innovation Authority. This programme currently involves 18 technological incubators¹⁹ whose aim is to reduce the risk of early investment for the private sector. These incubators exclusively work with early-stage investments where successful applicants receive 85% of their funding in the shape of public grants and 15% from the incubator's private sector partners.²⁰ As a portion of this funding is from the private sector it favours a free-market model as only the propositions attractive to the private investors get funding. There are similarities between this Israeli scheme and that of the Alacrity Foundation in Wales. The exact structure of Alacrity Foundations funding is not immediately clear, but its funds do seem to originate mainly in the private sector. Perhaps a larger proportion of public

investment in a foundation of this nature could help to reduce downside risk on the side of private investors and encourage increased investment in this sector.

Public Services is an important inclusion in Figure 6 with higher than average significance in relation to innovation. Within the results of this study, the majority of public services innovation is linked to the integration of technology into the public sector. Some examples of this type of public sector innovation are; blockchain use case experimentation in Ireland,²¹ the World Economic Forum linking cloud technology to public service innovation,²² IOT-based smart public service research in Sweden²³ and tech transfer initiatives in Lithuania hoping to benefit from the banking sector.²⁴ The latter scheme evidences previously discussed results from Section 1.1, where tangential sectors can benefit from technology spill-over from well-funded areas, such as fintech.

Although less prominent in this study, there are examples of non-technology related public service innovation. One such radical innovation highlighted by AMPLYFI is the region of Can Batlló in Barcelona.²⁵ The Can Batlló industrial area is an example of guerrilla urbanism sparked by the perceived slow action of the local administration in regenerating the area. Without a recognised central authority (and the bureaucracy that comes with it), a democratised public ownership model emerged in which an autonomous community centre was developed.²⁶ This centre hosts a variety of public services which include a library, workshops, auditoriums and communal gardens.²⁷

Section 1.4: Drivers of Innovation

This analysis points to several innovation drivers, the most prominent theme amongst these drivers, and the one carrying the most momentum, is Sustainability. Figure 7 shows the top-ten most significant drivers of sustainable innovation, ranging from more general drivers, Circular Economy and Climate Change, to tangible improvements around Air Quality and Greenhouse Gas Emissions. Broadly speaking these drivers can be split into four categories; energy, pollution, climate and waste reduction. The topic of Sustainable Development Goals (SDG) is particularly interesting as it permeates and underpins each of these four categories.

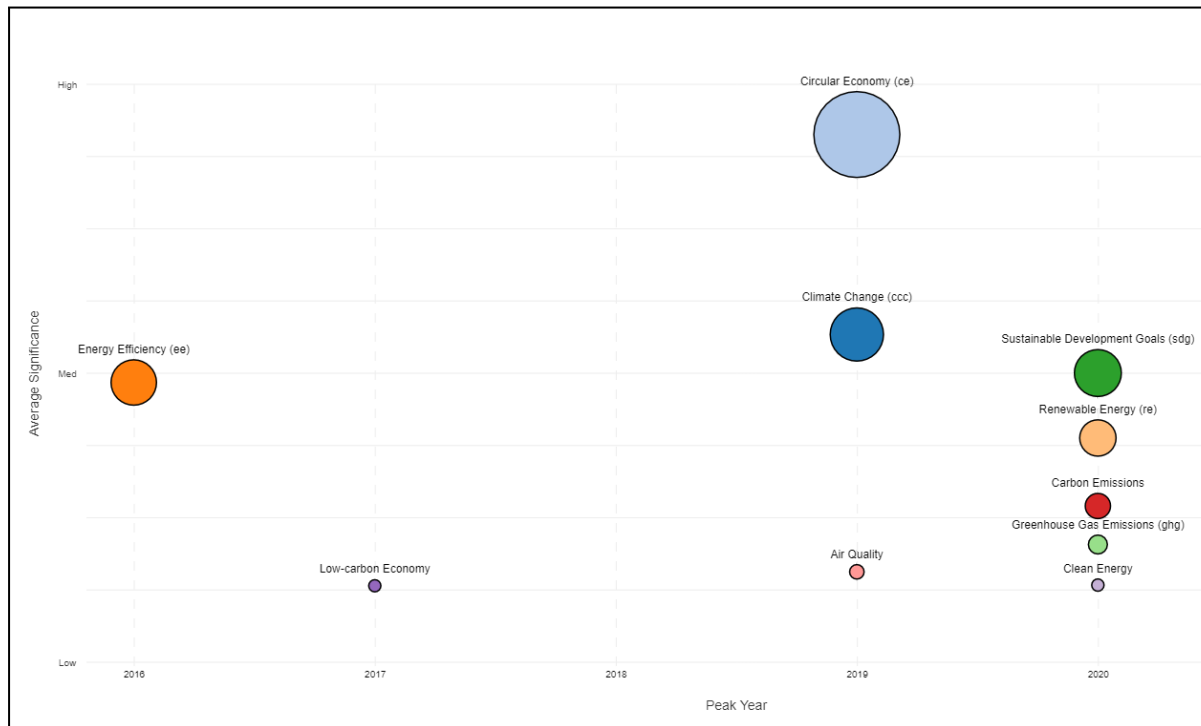


Figure 7 Top-ten innovation drivers linked to sustainability

The data suggests that SDGs are particularly influential in driving the discussion around sustainable innovation. The SDG topic in our data is strongly related to, and is contributing to the significance of:

- Circular Economy
- Climate Change
- Energy Efficiency
- Renewable Energy

These are also the top drivers in Figure 7. There is also a suggestion that the importance of SDGs could continue to grow as it reached its peak significance in 2020, the final year in our study.

As these SDGs are drafted by the United Nations²⁸ they are globally significant with linked policies emerging around the globe. One such example comes from Singapore in the form of a Sustainable Development Goal Innovation Loan.²⁹ This SDG innovation loan was pioneered by DBS bank and aims to accelerate innovation aligned to the UN SDGs. The interest rate charged on the loan is discounted if the recipient fulfils pre-agreed criteria around how its business is impacting SDGs. There are obvious

commonalities between the UN SDGs and the Welsh Government's Wellbeing of Future Generations Act³⁰, and perhaps more could and should be done to exploit this alignment. The concept of preferential treatment for businesses working to innovate and impact the Wellbeing of Future Generations Act is certainly something to be explored.

An interesting sustainable innovation topic highlighted in the AMPLYFI analysis was Water Management, and given Wales' natural abundance of this resource, it is worth exploring. This topic is also closely connected to the SDG topic suggesting a growing importance in the future, however, its calculated significance in our analysis of innovation has been falling. Commonly, water resources are publicly controlled so the calculated decrease in significance, when viewed through the lens of innovation, could mirror a lack of public investment into innovation in this area. This could be a sector that's ideally placed to develop PPP's mentioned in Section 1.3.

COVID-19 is a recent driver of innovation that exploded onto the global landscape in 2020. A general trend witnessed across the analysis was an increased link to innovation across many sectors touched by the pandemic. Within the analysis, the topic of COVID-19 Pandemic was most strongly linked to Artificial Intelligence, Supply Chain, PPE, Clinical Trials, Social Care, Public Services and Banking. In many of these individual topics, there is a noticeable uptick of significance in 2020 caused by COVID-induced innovation. There are still many unanswered questions as to which of these areas, if any, will continue along this path post-Covid.

Section 2: A Comparison of World-Leading Innovation Centres

Throughout the AI-led analysis of over 60,000 English language documents, AMPLYFI automatically extracted each location mentioned in every document. This mass extraction of mentioned locations allows a global innovation map to be built, as shown in Figure 8 (excluding the UK). As mentioned, this study was conducted exclusively in the English language and a different landscape would likely be drawn from a multi-lingual study.

In Figure 9, each location has a list of topics attached to it that link the region to innovation. This list represents the phrases most strongly associated with the documents that connect the region to innovation. Also note that each list doesn't indicate the overall innovation strength for the region, so from the lists alone conclusions about the comparative strength of each individual topic can not be drawn. For example, Beijing is the only list in which the topic Smart Cities appears, but both Singapore and Taiwan have a stronger link to the topic, without it appearing in their top-ten.



Figure 8 World map of the top ten global innovation centres comparing the strength of their association to innovation (excluding the UK)



Figure 9 Key topics that link geographical regions to innovation.

Figure 8 shows that Singapore has the highest overall connection to innovation in our study, followed by New York, California and Paris. There are three clear innovation clusters including East Asia, Northern Europe and North America. In this methodology the Middle East, Australasia, the Indian Subcontinent, South America and Africa failed to get an area into the top-ten, but that isn't to say that high levels of innovation were not uncovered in these regions.

The most prominent link across the top regions is the topic of Artificial Intelligence, occurring in nine of the ten centres. This reflects the findings from Section 1.1, which showed AI to be the most significant area of technological innovation. The heavy involvement between the innovation centres and AI has helped to cement their position as global powerhouses. Other common technology areas for these innovation centres aligned to previous findings in Section 1.1 include IoT and Big Data.

Also mirroring conclusions from Section 1 is the common presence of the topic Financial Services which links innovation to Singapore, New York, California, Hong Kong, Ontario and Shanghai. This is evidence that those innovation centres rely heavily on funding derived from the financial services sector. The power of this funding is highlighted in the fact that the top-three innovation centres are heavily linked.

Half of the innovation centres in Figure 9 have a strong affinity to the topic Business Model. This could be significant as it shows an understanding on the side of the innovator that commercialisation and the building of a sustainable business model are paramount for success. Another common thread among the innovation centres is their link to the topic of Supply Chain. The emergence of this topic is heavily related to the COVID-19 pandemic and highlights how COVID-induced innovation has impacted locations around the globe.

A unique and notable entry for Singapore, the leader from this methodology, is the topic, Global Market. Singapore's strong association with the Global Market signals two things about its success. Firstly, that it has fostered an external reputation as a centre for global business, no doubt made possible by its existence as a mixing pot of both Eastern and Western culture, but additionally, its small population size means that entrepreneurs do not set out to conquer Singapore and instead look global from day one.³¹ Enterprise Singapore, a Singaporean Government Agency, also appears to be influential, making the list of key topics. It aims to support the growth of start-ups and

SMEs, and unsurprisingly, it has a particular focus on global expansions as well as domestic growth.³²

Enterprise Ireland (EI) is another government agency with a high significance in this study and is influential in propelling Dublin as a leader in innovation. Whilst their goal is also to promote Ireland globally, the flavour of topics that link Dublin to innovation feel more internal or eurocentric with a high prevalence for the topics Irish Companies and European Commission. The role of Enterprise Ireland is discussed in more detail in Section 3.

The other organisation appearing to have a high level of regional innovation significance is the Industrial Technology Research Institute (ITRI), a non-profit research and development organisation active predominantly in Taiwan.³³ Their activity extends into brokering relationships between technology disruptors and established academic, government and corporate institutions. Outside of Taiwan ITRI forms international partnerships with the likes of the UK's Compound Semiconductor Catapult, and also showcases Taiwanese technology at global conferences.

The region of Ontario is the innovation centre most closely associated to its government with significant references to both the Government of Canada and the Federal Government. This suggests a centralised approach in Canada with government policy a powerful motivator for innovation. However, it is also noted that this centralised system does allow regional areas the freedom to explore innovation independently. The key government organisation responsible for much of this policy is Innovation, Science and Economic Development Canada, which although is not featured in Figure 9, is a prominent organisation across this analysis with many initiatives.³⁴

The omission of a central innovation authority can also inform on the landscape of innovation in a given region. It is perhaps noteworthy that both regions from the USA lack a strong link to a centralised government innovation authority. It is more common in the USA for the private sector to support innovation, which is evidenced by the topic Venture Capital (VC). Whilst this topic has not emerged in Figure 9, the analysis does show that its link to the USA is far stronger than any other location. A potential strength of a system favouring private investment is its acceptance of failure and the difference this then makes to risk appetite. A high net worth individual might expect to

occasionally see a loss in the hunt for a large reward, however, when spending public money risk appetite is generally lower as the poor use of public funds is rarely forgiven.

Another phenomenon uncovered in Figure 9 is a person-orientated approach in the USA. The topic, Founder and CEO, appears as significant alongside both New York and California, suggesting that the personal profile of company founders can make a difference for the perceived innovativeness. The alternative suggestion is that innovation and disruption is indeed more likely to evolve from businesses where the founder is going to be a prominent driver. In any case, in a VC orientated environment, unsurprisingly, founder profiles become important to establish a track record and attract the right investment.

The profile of innovation in Paris is one of a unique nature with three of its topics relating to the EU (European Commission, Member States and European Union) and three topics closely aligned with sustainability (Climate Change, Sustainable Development Goals and Energy Efficiency). Whilst Paris is undoubtedly a centre of innovation excellence, exploration of the documents driving its link to sustainable innovation frequently lead to the Paris Agreement, rather than a direct link to Parisian activity.

The only other centre with a high proportion of sustainable topics is Taiwan, which is strongly linked to innovation through Energy Efficiency, Sustainable Development and Renewable Energy. Perhaps a surprise given its global reputation, but Beijing is closely linked to innovation through the topic of Climate Change. Without running sentiment analysis on this subset of documents, it is hard to tell if the relationship is positive, or mainly based around criticism, but there are plenty of documents positioning Beijing as a leader in sustainable innovation.^{35,36,37} This could be signalling genuine intent to lead this sector, or alternatively, the cynical would suggest the workings of a well-oiled greenwashing machine.

Section 3: Case Study - How has Ireland, and in Particular Dublin, Fostered Innovation

Section 3.1: Ireland's links to Innovation

The emergence of Dublin as a centre of innovation in Figure 8 is an indication of the successful implementation of innovation policy in Ireland. Figure 10 shows a selection of key topics from this analysis that exhibit a link to Ireland. In this graphic, the size of each word relates to the average significance of the topic in relation to the analysis as a whole and does not directly relate to the strength of its connection to Ireland. With that in mind, the significance of the topic Enterprise Ireland (EI) is impressive as it has a high significance in comparison to all topics across the entire document corpus, not just those related to Ireland.



Figure 10 Key topics and entities that drive the link between Ireland and Innovation

One of the reasons for EI's high significance is the amount of media attention it receives, especially within Ireland where it is a high profile organisation. One strategy it employs to keep itself at the front of people's minds is effectively reporting statistics and performance. It commonly reports the number of jobs it is supporting across Ireland, and job creation translates very well into media headlines.^{38,39}

EI is also very active across several functions; from fostering innovation partnerships to entrepreneur education and direct VC funding. Domestically it aims to support entrepreneurs by providing an environment for them to thrive. One such example of this is its partnership with Arclabs in Ireland's South East region.⁴⁰ In this example EI is

helping to fund an entrepreneurial platform alongside researchers at The Waterford Institute of Technology. By colocating with a research centre it shows EI's desire to bridge the gap between research and enterprise by encouraging the commercialisation of Ireland's research and development output.

Enterprise Ireland can also be seen to be active at the local level showing a strong affinity to the topics Local Enterprise Offices (LEO) and Local Authorities, both of which are present in Figure 10. LEOs are a separate, but closely linked entity to EI and act as the first port of call for fledgeling entrepreneurs and micro-businesses. There are 31 LEOs across Ireland⁴¹, whose work supports thousands of jobs and enables successful businesses to graduate into the mentorship of EI to advance their growth.⁴² Ireland appears to have a mature support network that demonstrates a cohesive package, offering support from very early-stage businesses through to those looking for high growth and scale.

The opportunity for innovation that EI affords Local Authorities was uncovered in an example where EI partnered with Smart Dublin in 2018 to address Local Authority challenges with a €700,000 fund.⁴³ This scheme was structured in a way to allow small businesses to address a set of pre-defined challenges. Local authority innovation is certainly an area that EI takes seriously and is something it deems to be an exportable service. In 2020, EI launched a UK Local Authority Report that explains the structure of all 353 UK councils, and the opportunities they present for Irish business.⁴⁴

It is unclear if the 2018 domestic scheme is related to the UK report in 2020, but it follows that a successful 2018 scheme would have encouraged EI to think about exporting the innovation. The UK Local Authority Report, which includes Welsh local authorities, also highlights Enterprise Ireland's willingness to partner with the UK post-Brexit. However, the need for EI to invest in this report at all signals a problem about the complexity of the UK's local authority structure. This problem is even more acute when devolved regions, such as Wales, are considered. The current structure can inhibit Welsh local authorities from being able to innovate themselves when funding channels and strategy between Whitehall and Welsh Government are misaligned.

Alongside partnerships with the UK, its closest geographic neighbour, EI also extends internationally,⁴⁵ however the largest part of its international influence is focussed in Europe with numerous overseas offices, a policy which has been accelerated

post-Brexit.⁴⁶ An example of a pre-Brexit European partnership pertinent to Wales is a reported interaction with Enterprise Scotland, which saw the organisations work together on innovation projects in the water sector and energy efficiency.⁴⁷ Both of these could have a high degree of relevance to the Welsh economy and begs the question: why this wasn't happening in Wales? If there is not already an ongoing partnership with Enterprise Ireland it should be explored.

The level of activity of EI in the VC landscape is truly impressive with multiple accolades. In Pitchbook's analysis of the global VC landscape, between 2010 and 2015 EI was the third most active VC in the world,⁴⁸ and since then has taken second place in the 2019 rankings⁴⁹ and was the number one most active VC fund on the globe in 2020.⁵⁰ However, this measure relates to the number of deals and does not factor in the value of the deal or its quality. Beside this large number of investments, there is also evidence to show that EI is involved in socially-aligned, thematic investment drives such as a programme last year aimed at increasing female entrepreneurship.⁵¹

Another area in which EI is able to leverage its VC spend is to drive Foreign Direct Investment (FDI), which alone is already a key driver of Irish innovation, as shown in Figure 10. Similar to the Israeli strategy discussed in Section 1.3, last year EI invested €10 million with US-run, Luxembourg-headquartered VC firm Middlegame Ventures, which specialises in fintech. As a result, Middlegame has opened an office in Dublin and are actively looking to invest in the region with a €20 million fund for Irish fintech companies.⁵²

Promoting FDI has long been a successful strategy in Ireland, a substantial proportion of this success can be attributed to IDA Ireland (Figure 10), the organisation tasked with attracting foreign investment. The work of IDA Ireland, coupled with government policy favourable to corporations (including around corporation tax), has seen Dublin become a globally significant tech hub. Figure 11 shows a selection of tech giants with European headquarters in Dublin.



Figure 11 Dublin is a globally significant tech-hub with numerous high-profile European Headquarters

Once IDA Ireland has secured an active Irish footprint for organisations like the tech giants in Figure 11, EI is then able to leverage its influence and drive further value for the region. An example of this is a partnership between EI and Microsoft allowing Irish start-ups to access computational resources and business software.⁵³ However, strong the relationship between the tech giants and Dublin, plenty of questions remain around if this type of FDI leads directly to innovation.⁵⁴

Section 3.2: Exploring Ireland's Patent Landscape

A common method of evaluating a region's aptitude for innovation is via a weighted measure of patent activity by population size. The analysis of this measure may shed light on the relative success of Enterprise Ireland, IDA Ireland and the role of Dublin's Tech giants. Figure 12 compares the number of EPO patents for Ireland and the UK.^{55,56}

Whilst it is evident that Ireland has consistently completed a higher number of per capita European patent applications, in the 3-years from 2018-2020 it has doubled its lead over the UK. Between 2010 and 2017 this deficit was hovering close to 50, but by 2020 this was up to 100.

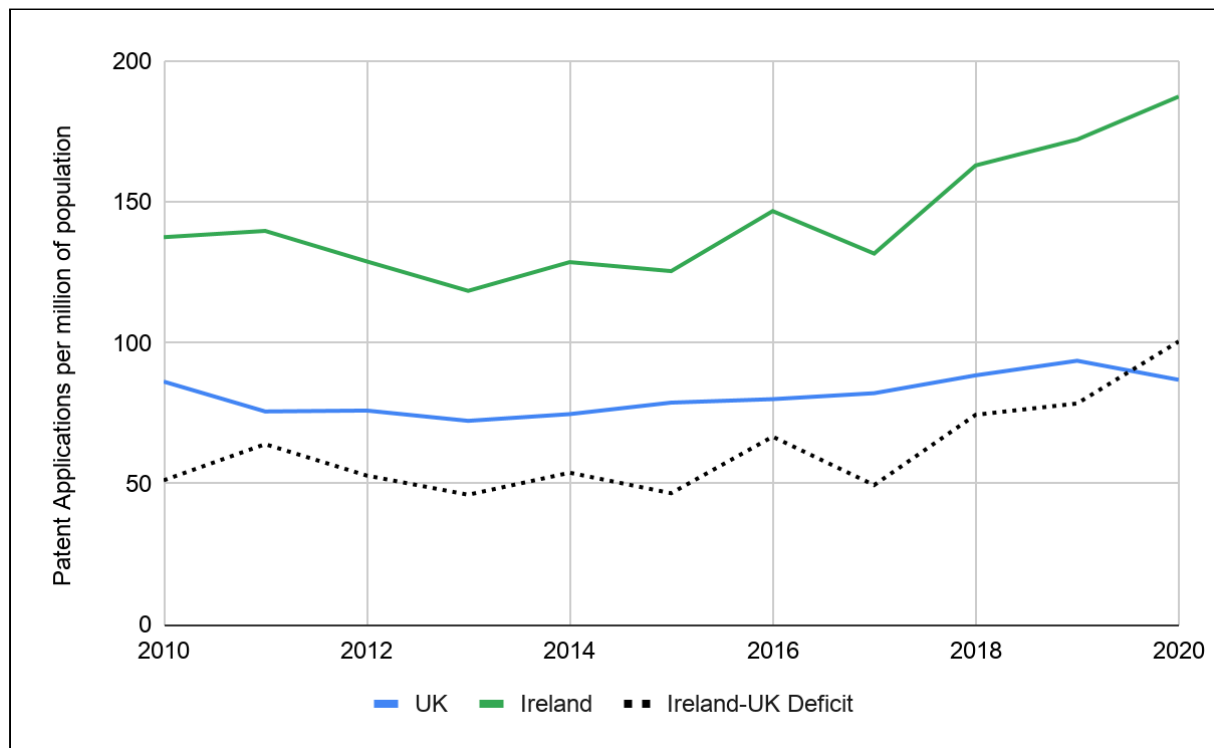


Figure 12 Patent applications for the UK and Ireland per million of population

Interestingly, it doesn't look like the tech giants from Figure 11 are making a direct significant contribution to this increase in patent applications. EPO data shows that in 2019 and 2020, none of the tech giants were on the list of top-patent applicants. At this point, it is worth pointing out that per capita patent applications is a relatively simplistic measure, and may not accurately reflect the increase in digital skills and indirect effects of large corporations on the regional economy.

Further exploration of the patent landscape in Ireland uncovers several interesting comparisons with the UK. Figure 13 and Figure 14 show the top-six patent technology areas in 2020 from Ireland and the UK, respectively.

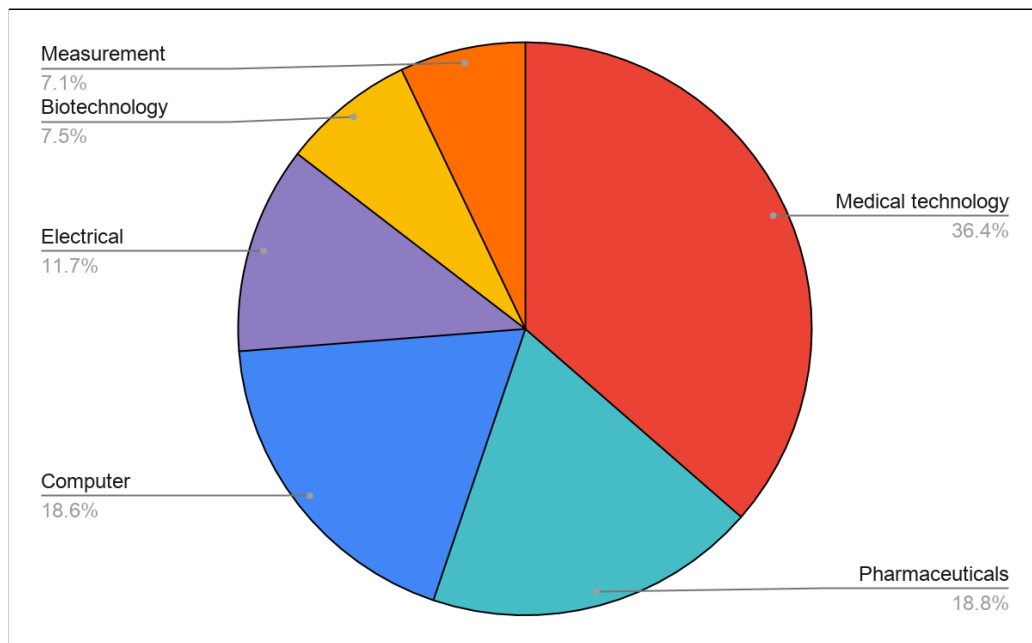


Figure 13 Ireland top-six patent technology fields by the number of applications in 2020

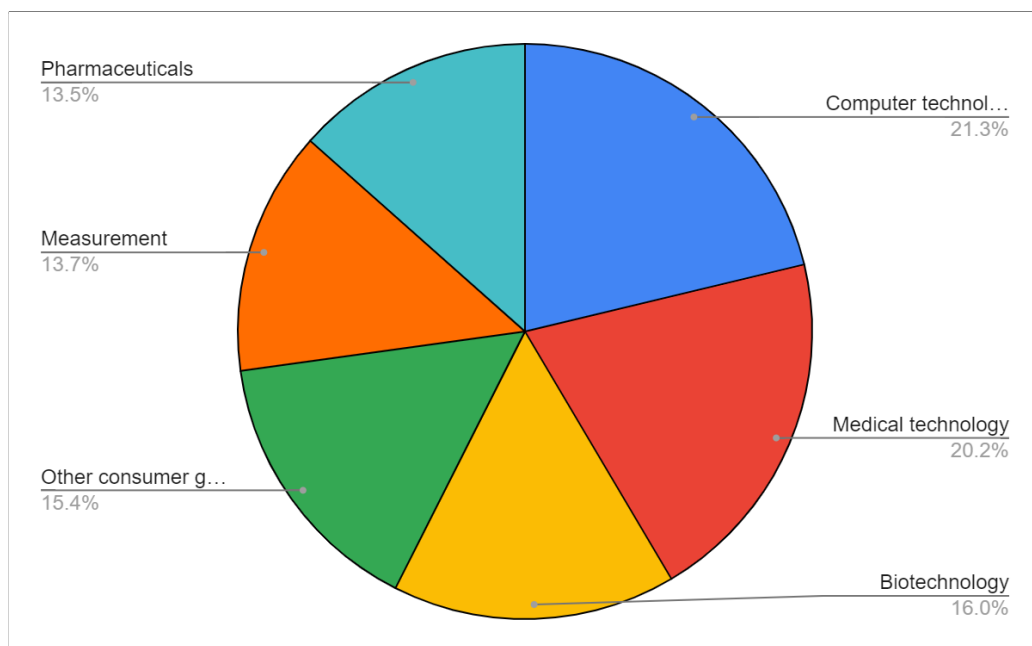


Figure 14 UK top-six patent technology fields by the number of applications in 2020

The comparison of UK and Ireland patent technologies reveals that Ireland is more specialised with a greater proportion of patents in the related fields of medical technology, pharmaceuticals and biotechnology. Whilst the UK is also strong in those sectors, it is less specialised signalling more thinly spread research funding. In line with EU Smart Specialisation policy, pharmaceuticals/biotechnology and medical technology

were recently highlighted as part of six strengths in a government report into future manufacturing opportunities in Ireland.⁵⁷

The specialisation exhibited by Ireland's patent areas is likely to be contributing to its increasing per capita application rate. AMPLYFI's wider analysis into innovation backs up the Irish Government's assertion of strength in medical technology with Ireland found to be in a privileged position in this sector. Figure 15 shows the European cities with the highest affinity to the topic of Medical Devices. Dublin is second only to London and three of the top-ten locations are in Ireland.



Figure 15 Top ten European cities by association strength to the term 'medical devices'

A final differentiator between Ireland and the UK in terms of patent applications is the proportion of patents authored by universities. In 2020 three of the top-ten applicants in Ireland were universities (Trinity College Dublin, University College Dublin, University of Ireland Galway) whilst in the UK only one of the top-ten is a university (University of Oxford).

Section 4: Case Study - How has the e-Estonia Programme Affected Innovation

When analysing public sector innovation, a location that is commonly referenced as a global leader is that of Estonia. The reason behind this reputation is its unique government and public services platform, e-Estonia. To lift the lid on this platform and explore its effects on innovation, AMPLYFI has completed a separate piece of analysis. This section centres around the analysis of 700 documents discussing e-Estonia.

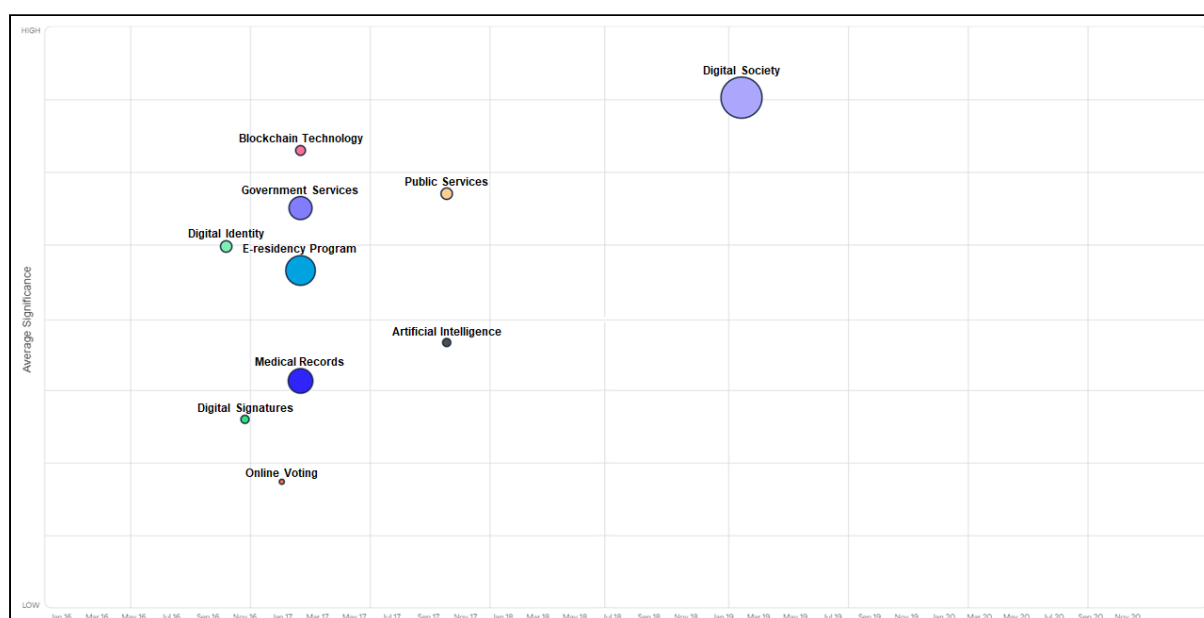


Figure 16 Key topics highlighted in a study into the e-Estonia scheme

The e-Estonia platform is a digital government services platform that allows Estonian residents, and so-called e-residents, to access a large variety of government services.⁵⁸ Figure 16 shows some key topics from the e-Estonia study and highlights the frequency of their discussion and the timing of peak discussion.

The most prominent topic is Digital Society which is directly related to how the media, and the Estonian government, tend to classify the scheme and it acts as a good summary for what the platform hopes to achieve. The majority of other topics reached their peak in late-2016 and 2017 suggesting that this is the period in which the e-Estonia scheme was receiving the most attention.

A particularly important topic in Figure 16 is Digital Identity which is the technology at the heart of Estonia's innovation. This topic has a relatively small bubble size for a topic with its average significance, which suggests it has held a constant level of mentions without a one-off large peak. This type of significance profile is usually indicative of a topic that is likely to remain important in the future. Underpinning and enabling the use of digital identities are Digital Signatures (Figure 16), which enable Estonians to access the suite of e-tools supplied by the government. Enrollment into the government digital identity scheme is mandatory and once registered, users can remotely access government systems, health services, transportation services, education resources, open bank accounts and even vote in government elections.

During an attempt to signal its intention to export its public service innovation, the Estonian government has claimed that the adoption of digital signatures has saved the nation 2% of its GDP.⁵⁹ The justification behind this claim was not elaborated upon. Thinking of an analogous system for Wales, it is highly unlikely that mandatory enrollment into a digital identity system would be desirable, and the benefits achieved by a partial rollout would be reduced. It also raises a question about digital skills. If the main focus of public services moves online, it risks excluding sections of the population who don't have the skills, or means, to access them. It is quite probable that some of the most vulnerable in society would fall into this category.

Leaders at e-Estonia are not ignorant of the need of population wide digital literacy to make the programme a success. With support from the media, schools and state-funded courses, Estonia has built engagement to a level where 95% of its population declares taxes online and 97% of retirees apply for pension payments online.⁵⁸ The lessons learnt on Estonia's journey could be particularly applicable given the recent Welsh Government Digital Strategy for Wales Report.

The link between e-Estonia and Blockchain Technology is clear from Figure 16 and highlights that the country is actively adopting the technology. A good example of this adoption is the way in which Estonia administers its public records system. Whilst its public record system is not held directly on blockchain, it is protected by a blockchain validation mechanism, meaning each modification and request to view is traceable.⁶⁰ In practice, this allows Estonians ownership of their own data and in the context of medical records allows individuals to lock or unlock access to their medical records

remotely⁶¹, and monitor all attempts to view them.⁶² However, there are also sources out there that suggest Estonia isn't as 'on the blockchain' as some would suggest.⁶³

A major innovation highlighted in Figure 16 is Estonia's e-Residency Programme which allows entrepreneurs located outside of Estonia to open a business within the country, open a bank account, reap the benefits of their digital ecosystem and access the European Economic Area.⁶⁴ The Estonian government's public dashboard⁶⁵ shows that at the time of writing there are over 79,000 e-residents from over fifty countries who have opened over 15,000 companies.⁵⁸ In the post-COVID world of remote working, this type of programme could become increasingly popular.

As well as a potential boost to domestic employment, the e-residency programme allows the government to generate tax revenue from e-resident businesses. As you would expect, Estonia's tax services are also linked to their digital ecosystem and allows the swift filing of taxes for residents and e-residents alike. Since 2014, tax revenues and fees from the e-residency scheme have topped €41 million, and as of summer 2020, tax revenues alone were €1.3 million per month.⁶⁶

Increases in tax revenue look and sound great, but the Estonian government would perhaps have been hoping that its public services innovation would have spilt over into the private sector, however, scant evidence of a direct link is visible.

The implementation of the e-Estonia digital ecosystem has been well-received globally with our analysis finding English language documents published from over fifty countries. Sentiment analysis of these documents is summarised in Figure 17 and shows generally positive results both internationally, and domestically within Estonia.

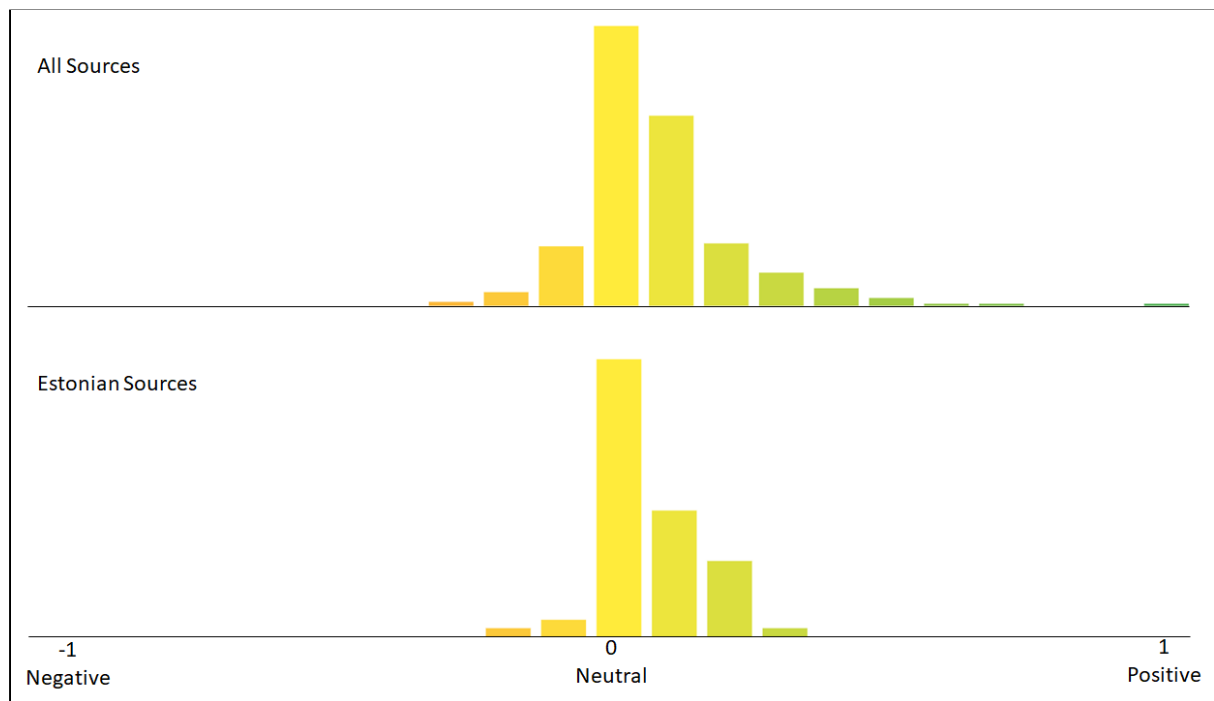


Figure 17 Sentiment analysis on documents talking about the e-Estonia scheme showing all global sources and Estonian sources only

With sentiment analysis tending towards the positive it can be interesting to lift the lid by exploring some of the less common, negative sentiment coverage. Two key examples of this coverage stand out, one is published from the United States and the other from an Estonian source. Firstly, in 2018 it emerged that the e-Residency program had been exploited as part of a scandal at Danske Bank that enabled money laundering and potential sanction breaches.⁶⁷ Whilst the second piece of negative sentiment, published from Estonia, points out that not all innovations lead to better outcomes for the local community.⁶⁸ An example of this thinking is that digitalisation usually results in a decrease in the number of paid jobs, not an increase.

Section 5: Case Study - Manchester as a Centre for Innovation

The document used to commission this piece of research included a list of cities and regions that were of interest as a comparator to innovation in Wales. This list included the UK cities of Edinburgh, Glasgow, Manchester and Birmingham alongside the European regions of Flanders, Baden-Württemberg, Brittany and the Basque Country. A small study was completed to compare which of these regions had the strongest association to innovation. The results of this study are shown in Figure 18. Note that only English language documents were analysed and that the region of Flanders was omitted from the study as the City of Brussels (the capital of the region) is inextricably linked to a great deal of general EU activity not related to the Flanders region.



Figure 18 Connection to innovation for comparative regions highlighted by the commission document

In this analysis, the regions in mainland Europe, whose native language is not English, tend to have lower links to innovation when compared to the UK cities. This being said, the region of Baden-Württemberg is significantly more connected to innovation than both Brittany and the Basque Country. The overall leader from this set of locations was Manchester, with second and third a close race between Edinburgh and Birmingham.

As Manchester has shown itself to have the strongest connection to innovation, the rest of this Section will discuss the reasons for this association. Figure 19 highlights the key topics which are driving the link. As has been common in other centres of innovation the topics of Artificial Intelligence, Internet of Things and Smart Cities are all prominent, although AI isn't dominating as it has in larger centres of innovation. The topic of Smart Cities has peaked the most recently and could be carrying more momentum than other drivers as the Northern Powerhouse Initiative drives its Smart City credentials.⁶⁹ Manchester has previously been linked to Smart Cities through its use of open-data innovation.⁷⁰

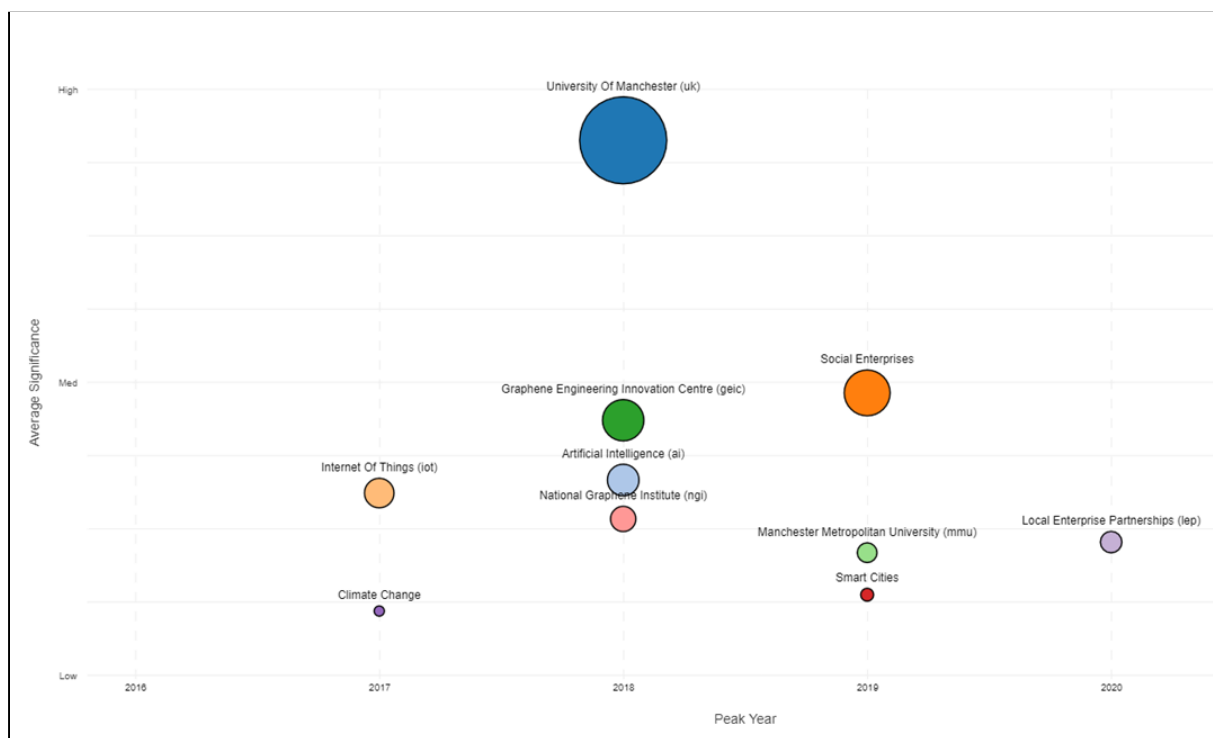


Figure 19 Topics and institutions driving the connection between Manchester and innovation

The most significant topic in Figure 19 is the University of Manchester, with Manchester Metropolitan University also well represented. The main reason that Manchester University is considered so innovative is through its relationship to graphene. The super-material graphene was first isolated at the University of Manchester in 2004⁷¹ and in 2010 the research received a Nobel Prize.⁷² Since then, the university has been very successful at capitalising on this discovery by concentrating efforts into this area in which it has already developed a world-leading position. Figure 19 shows the significance of the National Graphene Institute and the Graphene Engineering

Innovation Centre, both of which were opened by the University after developing their reputation. The National Graphene Institute was opened in 2015 benefitting from dual funding from the UK Government and EU Regional Development Fund (EU RDF)⁷³ and has since collaborated with industry,⁷⁴ international research centers⁷⁵ and has even been visited by China's president, Xi Jinping.⁷⁶ The University's Graphene Engineering Innovation Centre opened in 2018 and attracted most of its funding through FDI from Abu Dhabi⁷⁷ (indirectly through its sovereign wealth fund), with secondary funding from the UK Government via a Local Growth Fund.⁷⁸

Besides the work on graphene, the University of Manchester directly targets innovation through its Innovation Factory, a University organisation whose aim is to drive the commercialisation of the University's research. A recent example of this work includes the early-stage development of tests to diagnose Parkinson's disease.⁷⁹

Figure 19 also points to the influence of Greater Manchester's Local Enterprise Partnership (LEP), whose significance peaked last year on the back of a £3m investment to support early-stage VC funding for the city through the COVID-19 pandemic.⁸⁰ LEPs are partnerships between local authorities and local business which do not receive any official public funding. The whole of England is covered by the jurisdiction of a LEP, and whilst some jurisdictions cover a large area, it is evident that in the North-East area surrounding Manchester there is a cluster of three, smaller and more concentrated, LEPS (Greater Manchester, Sheffield City Region and Liverpool City Region).⁸¹

Manchester's innovative reputation is also supported by organisations such as MIDAS and Health Innovation Manchester. MIDAS has the job of promoting inward investment into the region, including from both FDI and domestic sources. A 2019 report from Manchester City Council links MIDAS to investments into the city from Amazon, BNY Mellon, Jaguar Land Rover, Hewlett Packard and Fitch Ratings.⁸² More recently, MIDAS has been involved in the Innovate Manchester scheme, an events programme used to help boost the profile of the city.⁸³

Health Innovation Manchester is focused on healthcare innovation for the Greater Manchester region and stems from the devolution of Greater Manchester's healthcare budget in 2016. As well as working with academic partners to advance research, the organisation funds healthcare innovation through its Momentum Innovation fund⁸⁴ as

well as running the Research and Innovation Health Accelerator,⁸⁵ part-funded by the EU RDF.

Alongside the National Graphene Institute, this is the second link identified between Manchester and the EU Regional Development Fund in this section. This raises the question about the potential impact of Brexit on innovation within the UK and especially Wales, who according to the think tank Institute of Government, is second only to Cornwall in the amount of per capita funding from EU structural funds.⁸⁶ The UK Shared Prosperity Fund is slated to replace EU structural funds in the future and projects already running will continue to be funded by the EU for the agreed lifetime of the project.⁸⁷

The most recent addition to Manchester's search for innovation is the Innovation Greater Manchester initiative, in which leaders from business, academia and local government have released a blueprint that maps out how Manchester could benefit from a £7bn economic boost.⁸⁸ It includes backing from Greater Manchester's LEP and it is hoped that the initiative could be part of the government's plan to level-up the north.

Supplementary Materials

How to Interpret AMPLYFI Graphs

Word Clouds

AMPLYFI's AI-insights platform uses machine learning to analyse vast quantities of open-source unstructured content (academic papers, patents, news items, journals, blogs, government white papers etc.) harvested from the internet. Unsupervised algorithms analyse the content to find and report keywords (or "Topics") that exist across the entire set of documents. Having discovered these topics (potentially thousands for each piece of analysis), it then uses a range of proprietary techniques to statistically quantify how "strong" or "prevalent" each topic is relative to each other. For any subject or area of interest, this is essentially a quantifiable measure of the strength of the global discourse or dialogue and the leading elements within it. Word Clouds are a powerful way for the machine to present and visualise to the reader what those leading topics are and how they, at a very high level, rank alongside each other. Word Clouds enable users to quickly understand and appreciate how broad and complex their subject of investigation or interest is.



Figure 20 Word Cloud Showing Key Topics for the “National Assembly for Wales” Theme

Figure 20 shows the lead topics that the machine has identified that relate to the broad theme of the “National Assembly for Wales”. The machine has not been directed to find these topics but has identified them through its own analysis. This helps keep the analysis as unbiased and influenced by opinions and prejudices as possible.

Topic Landscape

The Topic Landscape takes the same elements that constitute the Word Cloud and adds an additional layer of complexity to the visualisation – namely the element of TIME. It enables users to quickly compare the relative positioning and importance of topics over the period of study. It shows when over the past years each topic reached its maximum peak (the X-axis), what its average strength over that same period was (the Y-axis), and the relative size of its maximum peak (bubble size).



Figure 21 Topic Landscape for Topics with the “National Assembly for Wales” Theme

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