BASC0023
The Knowledge Economy

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The Knowledge Quarter

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Executive Summary

The Knowledge Quarter (KQ) is a consortium of 100+ academic, cultural, research, scientific and media organisations occupying a one-mile radius around the British Library, including King's Cross, Bloomsbury and Euston. The KQ team knits these organisations together to promote knowledge exchange through a broad range of stakeholder engagement and member activity. Collectively, the geographic area of the Knowledge Quarter is the UK's largest innovation district.

In 2018, The KQ conducted an audit that highlighted the KQ area as a leading area for life sciences. With institutions such as the London School of Hygiene & Tropical Medicine, University College London and the Francis Crick Institute, the KQ area is highly concentrated with life sciences expertise, making it a prime location to establish a life sciences company. The purpose of this report is to refresh the understanding of the life sciences ecosystem in the KQ area and increase their awareness of knowledge clusters internationally. Four finalists at UCL BASc Arts and Sciences created this report surveying the current UK life sciences domain within the parameters of the KQ as well as knowledge clusters globally. As a deliverable, a database was created, mapping all the relevant life sciences organisations within the KQ area so that the KQ team can begin developing a flourishing life sciences ecosystem.

The UK life sciences field is evidently a major contributor to the economy. The COVID-19 pandemic has highlighted the high quality of innovation and research that occurs in industry and academia. This report focuses on the key role London plays, financing and capital-raising, talent, data and the NHS, all within the context of the life sciences. This report also discusses UK, EU and US clusters, highlighting the contrasts in each regions' visions. Lastly, the report details the methodology of creating a database mapping the life sciences ecosystem in the KQ region as well as provides an overview of what is currently present in the area.

Summary of Recommendations

(1) The KQ should focus on ***networking opportunities and community building*** to develop a flourishing life-sciences ecosystem that will facilitate knowledge transfer between industry and academia.
(2) ***Educational partnerships*** within the KQ can aid in achieving the UK Government's Vision by bridging the data science gap, amongst other benefits.
(3) KQ can act as a ***data hub***, allowing knowledge transfer between academia, industry and healthcare to facilitate development.
(4) KQ can focus on ***developing an environment to grow life sciences businesses***, rather than establish them.
(5) ***Collaborations beyond the KQ region*** can be developed to build a knowledge network.
(6) The collaborations within and beyond the KQ region can ***digitalised*** to facilitate awareness and potential data sharing.

UK Life Sciences Landscape

As the United Kingdom finds its footing outside of the European Union, ensuring that crucial and fertile sectors continue to develop has become a priority. One such sector is the life sciences industry, which is widely distributed across the UK and generates plenty of jobs. In 2015, this sector contributed £30.4 billion to the UK economy, supporting approximately half a million jobs. Given its importance, the government has set out to increase R&D spending to 2.4% of GDP by 2027. This commitment is evidenced by the $3.4 billion that the UK government spent on health R&D in 2019 (Office for Life Sciences, 2021).

This sector has strong prospects to boost economic growth and to create benefits for NHS patients. The UK is strongly positioned to lead in innovating and implementing new healthcare approaches. New innovations are also likely to transform the way the UK health system operates. For the NHS to be a collaborator of the life sciences sector, it is necessary that the gains made through the life sciences strategy benefits the NHS (Bell, 2017).

The innovation and research response to the COVID-19 pandemic, including the Oxford-AstraZeneca vaccine, highlights the capabilities of life sciences in the UK. Collaborations between industry and academia can be facilitated by knowledge clusters that contain life science-related firms as well as academic institutions. Such hubs have seen success in Boston and San Francisco in the United States and Basel in Switzerland. Geographic clustering of companies belonging to a particular sector brings benefits thanks to connectedness, dependency, knowledge transfer and shared spaces and services.

London's fundamental strengths in relation to life sciences derive from knowledge clusters such as the KQ. KQ is "a consortium of partner organisations of many different kinds but with one thing in common: [they] are all actively engaged in advancing and disseminating knowledge". The KQ region spans a one-mile radius around the British Library, right in the heart of London. This section of the report will review the UK Life Sciences industry within the parameters of KQ and suggest recommendations on how the KQ region can develop into a bustling life sciences cluster.

London

The first aspect that must be considered when building a life sciences cluster in KQ is its geographical location. London is a renowned global dominant life sciences cluster thanks to the co-location of world-class universities and clinical research hubs, alongside appropriate real estate and access to capital for biotechnology (biotech) and other innovation-led start-ups in medical science (MedCity, 2021).

Life sciences firms are concentrated in Central and Inner London, particularly those in medical biotech and industrial biotech (Greater London Authority, 2015). Within Central and Inner London, there are small concentrations around the main research facilities and bio-incubators, such as the London Bioscience Innovation Centre in the Knowledge Quarter. London provides an outstanding ecosystem for starting businesses in the science and technology industry, proving to be one of the best locations in Europe (Greater London Authority, 2015). London and the greater south east has around half of the UK's life sciences companies, world-class research centres such as the Francis Crick Institute as well as

leading universities, providing access to sought-after depth and breadth of life sciences knowledge. With a high concentration of relevant organisations, the networking opportunities and potential for collaborations are immense.

Networks are a key to innovation. Innovators need to talk and listen to a wide variety of individuals, leading to socially generated innovation. A powerful way to facilitate networking is through business incubators. Incubators are an important aspect of the infrastructure that underlines growth in the Life Sciences sector (Bell, 2017). They can typically provide specialist resources such as laboratory space, knowledge transfer and mentoring. 57% of life sciences start-ups formed between 2010 and 2015 were based in incubators, according to a BioCity report (BioCity, 2015). This networking is also bolstered by London's connectivity to the rest of the UK and the rest of Europe. It also is beneficial from a talent perspective as well as for establishing research partnerships (MedCity, 2021). The attraction of being located near a large graduate talent pool (29,600 life science graduates in London, particularly from University College London and Imperial College London) has led to life science occupiers relocating or expanding in London (Savills, 2020).

Although London is an outstanding ecosystem for life sciences, it is a victim of its own success (Greater London Authority, 2015). A real estate demand report conducted by MedCity in May 2021 highlights the increasing demand for space, rising faster than supply. One of the factors that has heightened life sciences real estate demand is the COVID-19-induced innovation in therapeutics, diagnostics and healthcare delivery. This real estate often requires technically advanced facilities, such as the ability to 'extract to air' in their laboratories. Growing needs for wet laboratory space that can deliver 'extract to air' capabilities are a growing difficulty for the property industry and planning authorities. And, the KQ region is where a significant proportion of R&D intensive life sciences organisations reside, meaning there is a high demand for specialist equipment (MedCity, 2021).

It is also important to keep in mind the digital advances in this sector that are driving a different real estate footprint requirement (Savills, 2020). Bioinformatics is on the rise as it supports therapeutics thanks to increased connectivity of real data between different stakeholders. The use of computational biology, informatics, AI and machine learning means that many processes, such as R&D and manufacturing, will no longer need to be in the same locale. What is now critical is that flexible, adaptable and expandable facilities are located where the talent is.

Finance and Capital

The UK is seen as an attractive market for investment in the Life Sciences, ranking second only to the United States in Foreign Direct Investments as of 2019. Furthermore, UK Initial Public Offerings in life sciences raised £133m in 2020 (How well is the UK Life Sciences Industry performing globally?, 2021). In 2020, £19.9 billion of life science-related capital was raised by companies headquartered in the UK, 23% higher than 2019 (Savills, 2020). This is underpinned by a competitive tax environment and strong overall investments in the sector.

London has been the dominant cluster in the UK and Europe in the context of capital raising. In 2020, London saw £2.4 billion of life science related capital raised by companies headquartered in the UK. This supply of finance typically comes from venture capital funds. Despite London seeing a significant investment in the sector in 2020, the increase in the average size of private capital raised since 2016

is only 61% while in the US it is 201%. Most UK venture capitals lack the necessary risk capital that is found in their American equivalents. Innovation in the life sciences sector is long-term ("patient capital") and capital-intensive. According to the HM Treasury, there is a lack of this type of capital, particularly at the later stages. This has made scaling life sciences companies in the UK a historical challenge, especially as it often requires up to 12-15 years to generate successful products (Department for Business, Energy & Industrial Strategy, 2021).

It is evident that patient capital is key for growth as seen in the series of UK companies that transition into large biopharmaceuticals. For instance, Oxford Nanopore, Immunocore and Adaptimmune have had over a decade of patient capital support from investors, and little to no reliance on venture capital. However, the latest data is showing that the sector continues to mature as the UK venture capital asset class in both technology and life sciences is becoming increasingly competitive (UK Bioindustry Association, 2021).

On a public level, the UK ranks as the second highest level of government spending on health R&D amongst the comparators, behind only USA. In terms of the tax environment, the Association of the British Pharmaceutical Industry (APBI) pointed out that the UK's corporation tax rate is the lowest in the G20. The CEO of the BioIndustry Association notes that "the [UK] tax environment is very positive and creditable compared to other countries, particularly in R&D tax credits". But, the UK ranks in the middle in regards to Capital Allowances, which makes it relatively less appealling to finance pilot and full-scale manufacturing facilities, compared to other countries (Office for Life Sciences, 2021).

People

In addition to securing appropriate funding levels, access to highly skilled talent is important for a successful life sciences sector. Many organisations in this sector rely on global talent, and fortunately, even post-Brexit, the UK remains the principal destination for scientists and global talent. Large corporations in particular prioritise access to skilled labour over other considerations, such as rental costs. Between 2003 and 2013, employment in the life sciences sector grew by 27% over this period across London as a whole, but Inner London, where the KQ is situated, experienced by far the fastest growth (42%), compared with growth of 11% in Outer London (Greater London Authority, 2015).

Although KQ houses the hub for EU movement - St Pancras International Station - there is a potential loss of talent due to increased immigration hurdles. Reducing barriers to the Tier 2 visa process and associated bureaucratic approvals could help ensure that non-UK staff can remain in the country. This is necessary, especially since European talent favours London over other cities; Berlin takes the top spot over London, perhaps due to post-Brexit perceptions.

Besides access to global talent, the UK life sciences sector is seeing a lack of access to the necessary skills and expertise, which is considered to be a barrier to innovation. Businesses are aiming to diversify their workforce and recruitment pool (Benns, 2021). Recent research highlights that a lack of digital skills was a particular concern for leaders in the life sciences sector (Leonard, 2021). The sector faces increasing competition from technology companies for specialist sector talent, such as computational biologists and bioinformaticians. APBI's skills surveys reveal that data skills continue to be highly sought after, with innovation in drug development impacting the types of skills the industry requires most (Pieri, 2019). Big data and informatics are predicted to underpin this sector's future

success. Life sciences talent need to be upskilled in the right areas through high-quality training, particularly as technology increasingly comes into play.

Similarly, through the COVID-19 pandemic, it became apparent that the life sciences workforce also lacked broader business skills around data and agility. Sir Paul Nurse of the Francis Crick Institute notes that the UK lacked individuals who understood both science and finance, pointing towards the USA where "[he] found there were real experts who understood the territory, who were in the investment industry and who had very close contact with academics". There is a push for convergent training for those in the life sciences sector and graduates to ensure familiarity with appropriate entrepreneurial, finance and business knowledge (House of Lords, 2018).

Data

It has been highlighted how important data skills are in this sector. Healthcare data is crucial in allowing the evaluation of the latest biotechnologies and the delivery of improvements to health and (Bell, 2017). But, the sheer multiplicity of data sources makes searching for the appropriate information extremely difficult and time-consuming. As a result, companies are sitting on existing insights that they are unable to fully capitalise on. This slows down the pace of innovation and robs it of the potential to gain new insights from existing ones.

To support the UK Government's Life Sciences Vision "of a healthcare system that is able to focus more on early diagnosis, treatment and prevention of disease and harnesses cutting edge innovation", data needs to be made accessible, in a trustworthy and transparent way (Department for Business, Energy & Industrial Strategy, 2021). The pandemic has highlighted that digital developments are essential. The opportunity now is for the Life Sciences sector to apply such approaches.

One of the most important resources is the data generated by the UK population that is covered within the NHS. A report by Ernst & Young valued the over 50 million records held by the NHS at as much as £5 billion per annum, delivering around £4.6 billion worth of benefit to patients per annum (Ernst and Young, 2019). The development of platforms to enable de-identified health data to be appropriately used to research and develop technologies would be of great benefit to patients in the system. The NHS has access to data that can shorten clinical trials. Unlocking the insights from this patient data is of high value to all key stakeholders in the life sciences ecosystem: patients, providers, businesses and payers. The life sciences sector and the UK government need to establish collaborative partnerships to facilitate the unlocking of these insights from NHS data.

One such opportunity for this is through the UK Government's recommendation of 'Digital Innovation Hubs'. These hubs would "contain comprehensive and secure data in primary, secondary and tertiary care as well as social care and community data for a population of between 3-5 million people". They would work to unite health data assets across the UK to make health data research and innovation happen at scale (Bell, 2017).

NHS

The healthcare system is facing a number of difficulties, predominantly exacerbated by the pandemic. The NHS can adopt and engage with the rapid novel advances occurring in the Life Sciences sector to address these challenges (NHS, 2020).

The UK Government has stated in their life sciences strategy that the NHS should be an active participant in the industry to improve patient outcomes, especially as the testing grounds for innovative products and therapies. The opportunity that now confronts the UK lies in the fact that these two huge sections of the economy are self-evidently mutually dependent. Despite this, the potential for co-operation has never been fully realised.

One of the perennial challenges in the NHS is the ability to scale. This impacts how companies decide to allocate resources for large-scale partnerships (NHS Confederation, 2022). And then, even when cross-sectoral collaborations do take place, it requires sustained resource provisions from both sides of the table. This is particularly a problem when the driver for establishing the initiative in the first place is lack of resources within the NHS. Disruptive technologies underpinning transformational change are more likely to arise from innovative partnerships (NHS, 2020). When the healthcare system, life sciences partners and academia work together, adoption of innovative technologies is accelerated.

Recommendations

Networking Opportunities for Community Building

Networking is one of the most distinctive and powerful aspects of cluster growth. Within the London science and technology ecosystem, there is evidence of some level of networking, but much of it is informal, especially within the Knowledge Quarter. This recommendation focuses on formalising these networking opportunities (Greater London Authority, 2015).

One way to go about this is by partnering with life-sciences specialist incubators as identified in KQ's 'Start-up Ecosystem' report. They can facilitate networking, along with knowledge transfer and mentoring as they strive to develop business and social networks to their resident companies in the form of intellectual and material resources. This would be particularly beneficial in cross-domain knowledge upskilling for experts in life sciences and those involved in venture capital and business.

When developing these networking opportunities, KQ needs to ensure that each event has a focus, such as 'Women in STEM' or 'Venture Capital in Biotech'. It is also necessary to facilitate the maintenance of the networks that will be built during such opportunities. Thanks to the pandemic, online tools have never been stronger. Utilising platforms such as Slack will aid in continuing to build a KQ life sciences community and strengthen relationships.

Lastly, hiring a Community Manager, a role that has come into existence over the past five years, would help ensure that community remains as a priority.

Educational Partnerships to Achieve the Life Sciences Vision

One of the unique advantages of the KQ is its highly concentrated diversity - whether that be types of organisations, talent or backgrounds. This means KQ can make use of flourishing cross-domain partnerships to develop the life sciences community according to the UK Government's Life Sciences Vision.

One type of partnership that has potential is educational partnerships. KQ can facilitate partnerships between businesses and educational institutes within the region. This can be in the form of apprenticeships for graduating A-Level students within bioinformatics, equipping them with tools to bridge the data science gap. This would also mean there could be less reliance on international talent for the meantime whilst immigration processes adapt to the recent Brexit consequences.

Universities in the KQ can also develop these partnerships with businesses by developing graduate schemes and internship programs for students at all degree levels. Businesses would also be able to tap into the life science research expertise found at these universities, which could benefit their product development or even lead to having them on their company's advisory boards.

The development of such partnerships would require internal KQ expertise in education, so it would be advantageous to have an expert in this area on KQ's advisory board.

Facilitate Open-Access Data Sharing

The UK Government has classified the better use of health data as a precondition to their Life Sciences Vision. As mentioned earlier, the KQ is highly diverse, including in data. Healthcare in the KQ region would have NHS health data while universities would have research data, both of which would have value to industry. Providing KQ innovators with smoother and quicker access to reliable, high quality 'real world' data alongside clinical and genomic data will support many aspects of business.

This can be done by making datasets available to KQ member organisations. However, as many stakeholders will be involved (including patients, data analysts, NHS and academic and industrial researchers), it is important that KQ provides them a voice when developing themselves as a data hub or open-access facilitator.

Focus on Facilitating the Growth of Life Sciences Businesses

It has been established that many life sciences organisations have started in the UK. However, there has been an issue growing businesses, especially in London. One tangible reason for this is real-estate. Working with the Camden Council, the KQ can identify any possibilities to develop laboratory space and other specialist spaces for industry and academia.

Another reason that has been attributed is the lower availability of patient capital. The patient capital gap slows firms' growth and dampens ambition. As a result of this, British Patient Capital has launched the Life Sciences Investment Programme. The KQ can behave as a resource centre for opportunities for accessing long-term finance capital and other financing opportunities. This resource centre role can be applied to different aspects that are required for growth, such as contacts of life-sciences specialist patent attorneys, the aforementioned health data and tax relief schemes (eg: SME R&D tax credit scheme).

International Knowledge Clusters

The concept of a cluster is associated with the knowledge economy, for its essence is the production and exchange of knowledge, rather than goods and services, and its development is directly influenced by a network effect. Active policies supporting innovation industries foster the formation of firms which increases the chances of innovation. This section of the report will review and compare the UK, EU and the USA's vision for knowledge clusters. Then, recommendations based on these policies will be suggested for the KQ's development of their life sciences cluster.

The UK Vision

The United Kingdom's general policy for knowledge clusters is focused on a strategy of innovation and development, which is to make the UK a global hub for innovation, by 2035. (UK Innovation Strategy Leading the future by creating it, 2021). The global vision of the policy framework is to boost innovation in the private sector and become a major force when facing global challenges regarding climate, biodiversity, prosperity, and security (UK Innovation Strategy Leading the future by creating it, 2021).

The vision entails four key actions. First, to unleash business, make the UK an attractive place for talent. To do so, the government intends to increase research and development annual public investments to 22 billion pounds. It also aims to reduce the complexities of formation and development for companies that innovate, by creating a digital finance and innovation hub between the Innovative UK and the British Business Bank. Additionally, they intend to invest 200 million pounds through the British Business Bank's life sciences investments programme (UK Innovation Strategy Leading the future by creating it, 2021).

The second key action focuses on people; it consists of making the UK an attractive and exciting place for innovative talent. The government would introduce new visas, revitalise the Innovator Route, and provide support for management, performance, resilience, and growth of small and medium firms (UK Innovation Strategy Leading the future by creating it, 2021).

Thirdly, institutions would be adapted to serve businesses. In order to meet their needs, they would independently review across the landscape of UK organisations undertaking different ways of research, development, and innovation. They would provide 127 million pounds through funds to develop research and development capacity and foster local growth across the UK. And they would invest 125 million pounds to help push economic growth through business and academic innovation (UK Innovation Strategy Leading the future by creating it, 2021).

Finally, the last key action concerns missions and technologies. The UK intends to foster innovation to confront major challenges faced by the UK and the world and drive competence in essential technologies. A new innovation missions programme would be created to face the most significant upcoming issues the UK and the world will be confronting. Moreover, they would identify seven key technology families that will transfer the economy of the country in the future, and introduce new partnerships to establish research projects led by business to develop key new technologies, worth 59

million industry, university and government investment (UK Innovation Strategy Leading the future by creating it, 2021).

With regard to Brexit, having left the European Union, the United Kingdom must take a new focus on international markets and provide solutions for world challenges. It must reconsider its immigration system to attract talent globally, instead of the former European focus. The UK must adopt global dimensions, and be ready for competition in the global innovation race.

The main focus of clusters in London is life sciences, especially medical and environmental, technology, biotechnology, social sciences, the creative sector, and communications. The common vision is the sharing and exchange of knowledge resources, improving health and social care, sustainable development, and of course innovation. The main funding ise public investments and the particular contributions organisations make for their production.

The EU Vision

The European Commission has introduced the European Cluster Partnerships to encourage the intensification of collaboration between clusters from Europe across regions and sectors. These EU Cluster Partnerships provide knowledge and resources to to joint strategies and work genuinely together. The aim is to undertake actions in the shared interest of their SME members. The ultimate objective is to catalyse economic growth and competitiveness in the EU zone. The common market is critical for cluster development and collaboration (ec.europa.eu, n.d.).

The aims of the European Union are, through the European cluster policy, to foster the development of world-leading clusters with competitive industrial transversal value chains across sectors. It would serve as a means for the EU industrial policy, and a catalyst for the regional and national innovation strategies. The latter would address the EU's value chains and position them globally. The strategy would support small and medium businesses across the 27 nations and promote cooperation across regions, countries, and sectors (European Cluster Policy Forum Towards modern cluster policy for industrial change and growth, 2018).

The framework of the policy for clusters consists of a new EU industrial policy, a strategy for promoting innovation in the European area, and for Start-up and Scale-up companies (European Cluster Policy Forum Towards modern cluster policy for industrial change and growth, 2018).

The priority areas for intervention for cluster initiatives are the following (European Cluster Policy Forum Towards modern cluster policy for industrial change and growth, 2018):

- Modernisation of industries and value chain connnections
- Investments of specialisation
- Entrepreneurship and small and medium business growth
- Collaborations across regions, nations and sectors
- Cluster management excellence aiming better SME support

The European Union cluster policy is relatively young but promotes broad innovation open to business opportunities provided by interregional and intersectoral, and across innovation policy purposes. It is based on contributions from diverse policy areas and levels (clustercollaboration.eu, n.d.). It serves

different policy goals and introduces new combinations such as the policies of innovation, regional development, entrepreneurship, small and medium companies, and international relations.

The EU's cluster approach for growth is grounded in the ideas of clusters as catalysts for innovation and industrial evolution, interregional and international cluster collaboration, and cluster excellence (clustercollaboration.eu, n.d.).

There are over 1500 clusters in the 27 countries of the European Union, with more than 200 regions. Clusters account for more than 25% of the EU's total employment. The EU takes a series of actions to address its cluster policy. First of all, they intend to create a partnership of clusters, in which these can work together and support industrial ecosystems. They focus on internationalisation, innovation, smart specialisation investments, and excellence. Secondly, the European Cluster Collaboration Platform (ECCP), that maps and supports the work of the partnership. The mapping of these clusters consists in finding a wealth of partners per country, region, sector, or industrial ecosystem. Additionally, there is the European Cluster Panorama, a report analysing the location and characteristics of clusters in the regions they are in. There is also the ClusterXchange program, for exchanges between clusters, SMEs, and Scale-ups and support of the organisations. Finally, there is the Advanced Technologies for Industry, a technology watch in the EU and abroad (clustercollaboration.eu, n.d.).

There are several specific cluster initiatives in the European Union (clustercollaboration.eu, n.d.). First, there is the investment in cluster excellence:

- Communities of knowledge and innovation (EIT)
- Cluster excellence programme (COSME)

Secondly, we have initiatives focusing on the promotion of collaboration:

- European Cluster Collaboration Platform
- Cluster internationalisation programme, Eur. Strategic cluster partnership (COSME)
- Interreg. (ESIF)

Thirdly, there is the cross-sector value-chain:

- European Observatory for clusters and industrial change, S3 Platform
- Cluster facilitated projects for new industrial value chains (Horizon 2020)

Finally, there is the cluster policy implementation through concrete initiatives launched under EU's financial programmes:

- COSME (cluster internationalisation and cluster excellence) - budget 40 million euros
- Horizon-2020 - budget 130 million euros

The latter is closely linked to smart specialisation strategies guiding about 121 million euros of European Structural and Investment Funds (ESIF)

The top service provided by the EU-27 cluster organisations are the facilitation of collaboration between members, providing support on research and development, and supporting external collaboration (clustercollaboration.eu, n.d.).

The cluster organisations specialised in life sciences and related fields: there are 65 membership organisations, with over 500 members, 60 clusters focusing on scientific research and development with over 500 members, and 30 clusters specialising in human health with over 500 members (clustercollaboration.eu, n.d.).

If we compare London's hub of knowledge to Boston or the ECCP, we can see some of the factors that differentiate the cluster. The policy and vision of the UK have different strategies regarding the development of clusters. First of all, the ECCP has a strong focus on the collaboration of organisations and clusters across the EU zone. The vision of creating a knowledge network in the EU to foster the development of regions, nations, and therefore the EU group, is supported by the digitalisation of collaboration. Through multiple platforms and means for partnership and investment flows, the European Union aims to create an extremely large digital hub, bringing together over 1500 cluster organisations, with hundreds of members each. The digitalisation of the collaboration of such a quantity of organisation can cause a network effect in every member that in turn will foster partnership contributing to the same mechanism. The vision of the UK focuses on fostering each organisation and cluster individually, with special regard to start-ups and small companies. The lack of sovereignty in EU policy-making doesn’t easily allow specific targeting. The latter can be a disadvantage, as start-ups and small companies represent a big part of the economy of both the EU and the UK, and are important key actors of technical and digital innovation affecting all sectors. UK’s policy fosters investment and innovation in a way that has a more direct effect. However, a focus on collaboration and partnership between clusters in the country and abroad could contribute to the exchange and sharing of information.

The US vision

In the US, cluster policy has been fairly weak but the strong point of the fundamental framework characteristics, especially the open competition in the combined US market, allowed the emergence of specialised zones with important cluster structures. Led by the private sector, cluster efforts then compensated for the lack of coordinated government policy in mobilising these clusters. But the framework conditions are essential to understanding why the US has a stronger cluster structure than the UK or the EU. Its federal system allows states to pursue their particular economic development policies, which in certain cases has allowed the strong development of a region towards innovation (ResearchGate, n.d.), e.g., Silicon Valley, California.

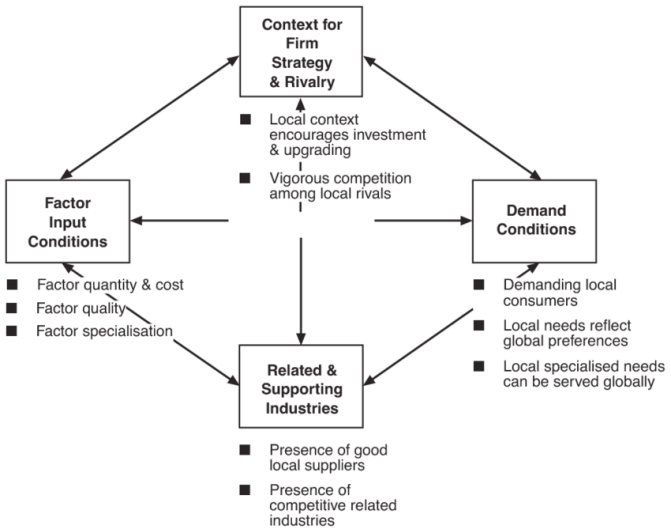

Figure 1: The competitive diamond framework (Scholarlycommons and Duranton, 2011)

In the competitive diamond framework, the government must foster every part of the diamond and strengthen the links joining them. The interactions between the parts contribute to each other. Then, certain policies are attached to the different parts of the diamond. The appropriate interventions will increase the size and competitiveness of the cluster. The bottom line of this framework is that clusters will generate competitiveness, contributing to the network effect of clusters (Scholarlycommons and Duranton, 2011).

Let's consider the case of Boston's innovation cluster. There are over 50 institutes, amongst which are Harvard and MIT (admin, 2018). In Boston, graduates do not only take academic advantage of the city, but afterwards, they contribute to the creation of new businesses and innovation, creating a positive turnaround of the brain drain many cluster regions suffer. After the US Chamber of Commerce, it is the best city for entrepreneurial growth and has the highest concentration of millennials in the country (admin, 2018). Hence start-ups and other innovative companies focusing on the development of new solutions to complex challenges in different industries are abundant. The main areas on which the Boston knowledge cluster focuses are life sciences, biotech, and digital health (admin, 2018). The quality of human capital is an additional factor that contributes to the strength of the Boston cluster. It is the third worldwide venturer of human capital investments with over 3.15 billion dollars, which represents a 7,5% share of the global venture capital investments, which focus on a rapidly growing sector (admin, 2018). The city has multiple hubs, where interactions of the ecosystems take place (admin, 2018).

The US federal system allows a certain freedom in policymaking that places like London or the EU for political reasons do not have. The economic policy of the state of Massachusetts is particularly prone to business making. As Boston is one of the most innovative cities in the world, it particularly benefits from its federal-state policy. There are no particularly interesting incentives with direct regard to innovation and clusters, but the economic freedom added to the academic wealth of the city, has allowed the development of a major innovation hub. In contrast, the UK has (or has had until now) fewer economic incentives for the development of private innovation companies. For example, the areas in which the clusters in London are specialised are much more diverse than in the case of Boston.

However, the latter is much more specific on rapidly and very productive sectors, e.g., biotech, life sciences, and digital health. Therefore, the main difference between the US and UK policies, causing the gap in knowledge production, is the economic approach to development.

Recommendations

Collaborations beyond the KQ region

KQ can take inspiration from the EU policy of bringing together hundreds of clusters by fostering collaborations with other life sciences clusters in the UK, such as Oxford and Whitechapel. The proximity and transport connectivity that KQ benefits from easily facilitates partnerships between clusters in the country and perhaps even abroad to contribute to the building of a knowledge network. Achieving this can be supported by the following recommendation.

Digitalising Collaboration

Digitalising the collaboration of such a large quantity of organisation can cause a network effect in every member that in turn will foster partnership contributing to the same mechanism. Similar to the ECCP, the KQ in collaboration with other life sciences clusters can develop a platform to visualise data on about the clusters. This would require mapping of other clusters, similar to what has been delivered to KQ. Additionally, through this digitalisation, there is the potential for a greater network for open-access data sharing.

Mapping KQ's Life Sciences Ecosystem

Methodologies

Sources for gathering organisations

A few sources were used to identify all the Life Science Companies in the Knowledge Quarter area. Our primary dataset was KQ's internal mapping of all the companies in the area. We then removed all the non-relevant firms and identified what kind of organisations were missing. We filled in the missing gaps with hospitals provided by the NHS database (nhs.uk, 2018). As there was a lack of biotechnical and pharmaceutical companies in our dataset we used the Office of Life Sciences' 2019 dataset to fill in the missing gaps (GOV.UK, 2019). We used postcodes relevant to the KQ area to select companies and added approximately one hundred companies to our dataset.

Our definition of Life Sciences

The Life Sciences can broadly be described as the fields of science that study living organisms such as plants, animals and humans (DePamphilis, 2019). A Life Science Ecosystem is generally considered to consist of all of the companies, organisations, and research institutions dedicated to improving the lives of organisms (mcamericas.org, 2021). Together with our advisory board, we came up with a narrower definition customised to the demographic of companies in the Knowledge Quarter area. We focused primarily on companies, organisations and research institutions related to human health. A broad range of companies were included such as publishers, charities dedicated to curing diseases, pharmaceutical companies, membership organisations of health professions, biomedical consultancy firms and even architectural firms that specialise in designing hospitals. Due to technological advances in the Life Sciences such as DNA sequencing, there are vast amounts of data.

For this reason, we included data science companies in our mapping, as they are a key component to a thriving ecosystem. Since there were many educational institutions in the KQ area, we incorporated all the ones that teach Life Sciences subjects, including primary and secondary education.

Company Features

Initially we identified the following features as the most important: address, postcode, category, year founded, company type, number of employees, annual turnover 2020, summary of organisation, KQ member/partner. The address is useful for identifying clusters within the ecosystem. The year the company was founded may reflect how established the company is. The company type outlines the nature of the firm according to Companies House. This reflects whether the company is private, public, non-profit etc. The number of employees and the annual turnover are a useful indication of the size of the company. Lastly, we included whether companies are a KQ partner to indicate which companies could be targeted for future collaborations.

On revision with our advisory board we also added a few more features. For example, whether a company is a knowledge producer or consumer, since KQ is centred around the sharing of knowledge. We also added a column on whether the company is primarily R&D, research or medical, as these are the key features of Life Sciences companies and it's useful to know what category a company falls into at a glance. We classified companies as 'R&D' if they undertook activities to innovate and introduce new products and services. The 'Research' label was assigned to educational institutes and charities/funds that focused on funding research. "Medical" was assigned to any organisations involved in the diagnosis, treatment, and prevention of disease. Lastly, the criteria of whether the headquarters were based in the KQ area was added. We found that some global companies had the primary headquarters abroad, but had several branches in the UK with their UK headquarters in the KQ area. For this classification we used the label "UK Headquarters" as opposed to "Headquarters".

Company Segmentation

Next, we came up with several ways to categorise the organisations. We first considered the approach of Standard Industrial Classification (SIC) codes, a system used by governmental agencies to classify industries by a four-digit code (Companies House, 2008). The main limitation was that the codes were not specific enough for the different types of biotechnical and pharmaceutical companies. The other form of coding system we considered is the segmentation codes used by the Office of Life Sciences (as seen in the figure) (Bioscience and health technology sector statistics 2018, 2019). This presented the opposite issue, where the segmentation was technical beyond the scope of organisations in KQ. Instead, we created a custom approach to classify the

Annex 4 – Segmentation codes

Biopharma Core (BP)	
Code	**Description**
BPA	Antibodies
BPB	Therapeutic Proteins
BPC	Advanced Therapy Medicinal Products (ATMPs)
BPD	Vaccines
BPE	Small Molecules
BPF	Blood & Tissue Products

Figure 2: Example of the segmentation codes used by the Office of Life Sciences

organisations. We took inspiration from the labels used on the UK Biotech Database (www.ukbiotech.com, n.d.) and combined it with more labels that accurately depicted the large variety of organisations in the KQ area, as seen in the figure below. We followed the UK Biotech definitions when categorising the technical companies under the first seven labels in the left column on the table.

Custom Segmentation Labels	
Biotech - Therapeutics & Diagnostics	Investors
Biotech / R&D Services	Membership Organisation
Biotech - other	Education
Pharma	Research Institute
Medical Technology	Charity
Digital Health	Tech
Suppliers	Data Science
Consulting	Grant making Institute
Healthcare	Media / Communication
Trade Union	Publication

Figure 3: Our approach to organisation segmentation

Sources for collecting data about companies

Once we had identified all of the relevant companies and important features, we used Google search to find the required information. Linkedin was one of our primary sources for finding general information such as the year the organisation was founded, where the headquarters were located and how many employees the organisation had. Company websites were also helpful for collecting general information. The revenue data was collected from a variety of sources, but mainly the websites Endole and Dun & Bradstreet. The latter used modelling to predict the turnover where data was not available. Hence, this column of our database should only be viewed as an approximation. Information about the company type was gathered from the Companies House website.

Limitations

There are several limitations to our database. Our data collection was limited by the information we had access to. For example, much of our employee data was taken from LinkedIn which may not have the most up-to-date information, since many companies do not regularly update their profile with such figures. Furthermore, the employee data was usually reflective of the whole company as opposed to the branch of the company based in the KQ area. Also, for turnover data we had issues accessing the Companies House data and had to use less reliable sources like Endole. Furthermore, we collected the biotechnical and pharmaceutical companies using the most recent Office of Life

Sciences dataset but unfortunately it was published in 2019. There may be several organisations that were founded after the dataset was published. This is particularly relevant since many new Life Sciences companies were started-up to respond to the demand of Covid-19. Another limitation is that the data collection was carried out manually and may include human errors such as a missed zero on a turnover figure or a mistype in the year an organisation was founded. We tried to minimise errors by dividing the dataset into sections and having another team member check each part. In addition, science and technological companies are often multifaceted and serve several different markets and therefore did not fall neatly into our categories. We were aware of this limitation from the start and tried to mitigate it by assigning multiple labels to them.

Analysis

To gain a better insight into the type of organisations that make up the KQ Life Science Ecosystem, we analysed our mapping dataset and created visualisations.

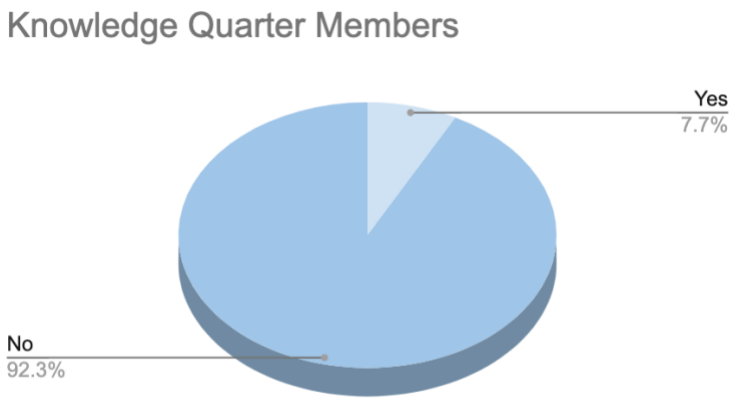

Figure 4: The proportion of organisations that are Knowledge Quarter Members

We found that only 7.7% of the Life Sciences organisations in the KQ area were already members of the KQ. KQ should increase their partnerships to allow their members to have more choice of Life Science organisation to collaborate with and to foster greater knowledge exchange within the Life Science ecosystem.

Organisations in the Knowledge Quarter can be classified by the focus of their work. We found that they can be categorised as Medical, Research, or Research and Development. Of the 247 organisations, 85 have a medical focus, which is the most represented category, followed by Research and development, with 64 organisations, and Research, with 45 organisations. Amongst the remaining 53 companies, 16 focus on a topic that does not fit into these categories, and 37 focus on a

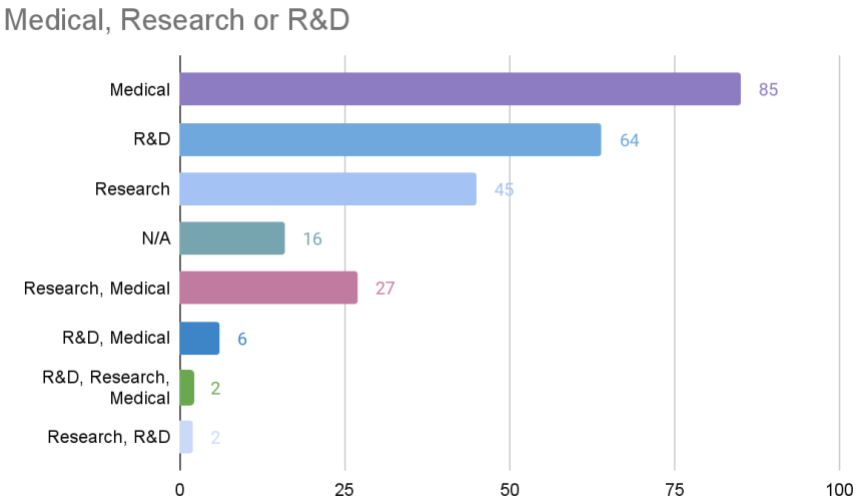

Figure 5: Number of Medical, Research or Research and Development organisations

combination of Medical activities, Research, and Research and Development. These findings have interesting implications for the cluster. The large focus on medicine will advance the creation of new treatments that will benefit patients and the NHS. Furthermore, having such a large proportion of companies focused R&D reflects the high rates of innovation within the cluster. Having another large proportion of companies carrying out research is essential to the generation of new knowledge and will in turn inform patient care and the development of new technology and treatments.

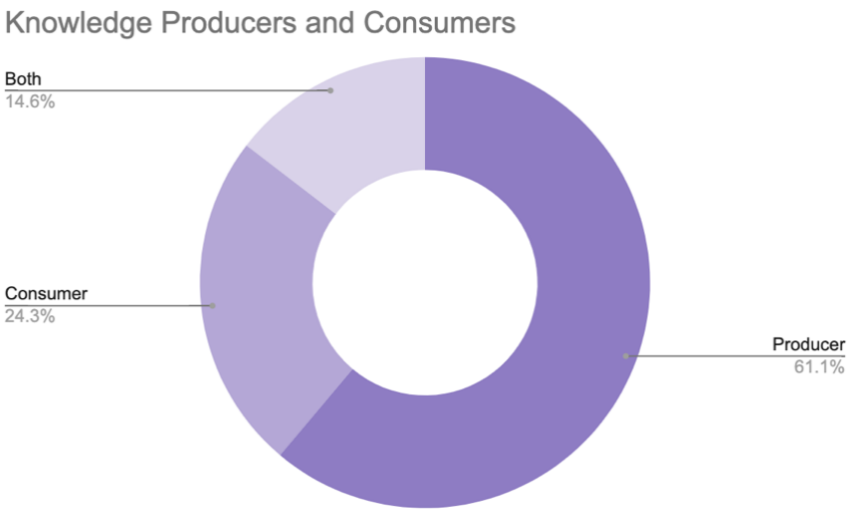

Figure 6: The percentage of Knowledge Producers, Knowledge Consumers and Both.

Since KQ is based around collaboration and the sharing of knowledge we included a category of whether an organisation mainly produced or consumed knowledge. All organisations do both to varying extents so for this classification system we looked at the main services an organisation offered to determine which category was more fitting. We defined “Knowledge Producers” as organisations that created new knowledge through research or through combining/sharing information or products in a new way. Examples of knowledge producers are research institutes, biotech companies, hospitals, and publishers. We found that the majority (61%) of organisations create knowledge in some form. This is a great asset to foster a thriving ecosystem full of innovation. Knowledge consumers were defined as organisations that do not directly create new information, for example, membership organisations. We found that 24.3% are knowledge consumers highlighting the demand for knowledge creation. Some organisations did not clearly fit into either category and had a fair balance of both creating and using information (14.6%).

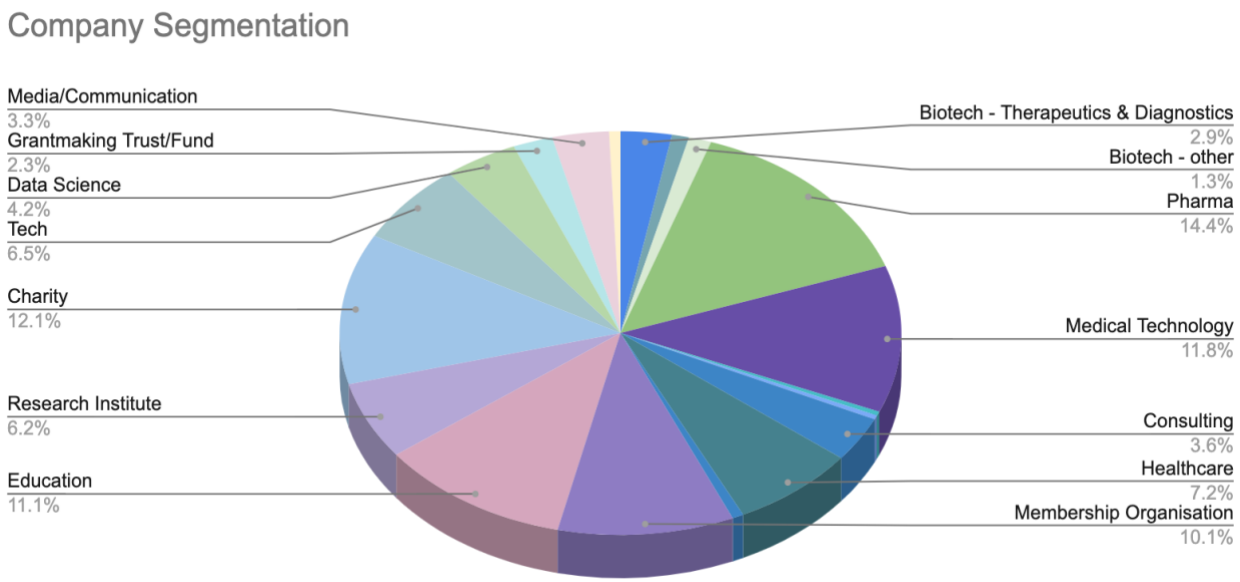

Figure 7: The percentage of representation of companies by category.

We defined 14 different categories representing the organisations. Organisations' representation varies from less than 1% (e.g., publishing companies) to 14.4%, Pharma being the most representative category. The diversity of the ecosystem of the Knowledge Quarter is an important asset for the quality of the knowledge exchange in the cluster. The greater the diversity is, the stronger the network effect is for companies of all categories. But it is important to maintain equitability in the different categories to avoid the increase of frequency of a sector or area of focus. Then knowledge will maintain its diversity.

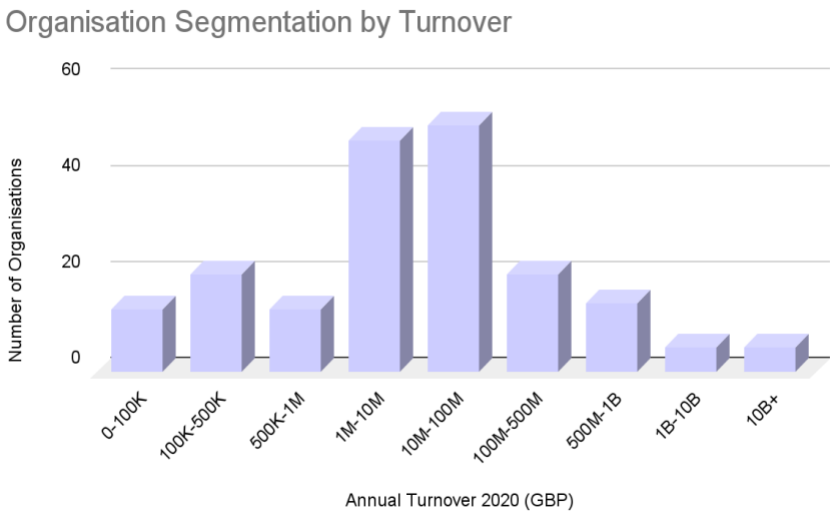

Figure 8: Number of organisations per Annual Turnover band

We created and assigned bands based on the range of revenue data that we had for each organisation. The graph hints at a Gaussian distribution with the majority of companies falling within the band of ten to one hundred million pounds and shortly behind at one million to ten million pounds in 2020. Unsurprisingly, there are more organisations falling into the bands of '0-100k' and '100k-500k' than in the last two bands of '1B-10B' and '10B+', since such high levels of turnover are less common. This is not a disadvantage since thriving ecosystems foster a start-up environment where new ideas are encouraged.

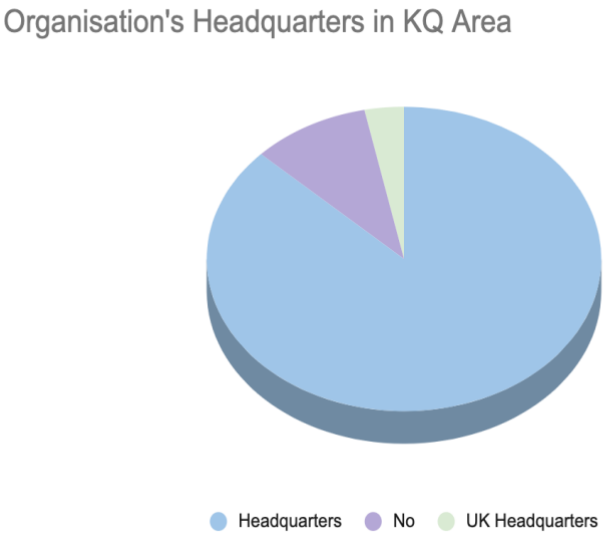

Figure 9: Headquarters of the organisations in the Knowledge Quarter area

We found that the majority (87%) of organisation had their headquarters in the KQ area reflecting the prime location of this Life Science cluster. One reason for such a high proportion may be that many of the companies are small to medium enterprises, with offices in only one location. Thus, they are solely based in the Knowledge Quarter area. Organisations without headquarters in the area are the second most represented (9.7%), followed by global companies with their UK headquarters in the area of the cluster.

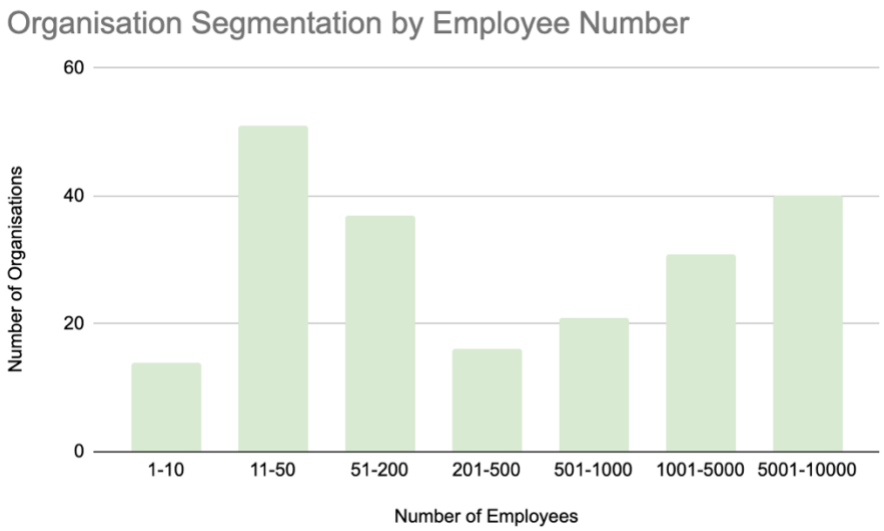

Figure 10: Organisation segmentation by employee number.

In regards to Figure 10, we can observe that most small companies, with less than 50 employees have the highest representation amongst all the 247 organisations. There are 14 companies with less than 10 employees and 51 with less than 50 employees. The second most represented companies by size are very large with 5000 to 10000 employees, followed by 37 medium companies with 50 to 200 employees. There are 31 large companies, with 1000 to 5000 employees. The least represented companies are medium-to-large companies; there are 16 companies with 200 to 500 employees and 20 organisations with 500 to 1000 employees. This shows that there is a good variation of start-ups and more established companies in the area, providing a good dynamic for collaboration.

Conclusion

This report was written for the Knowledge Quarter to refresh their understanding of the life sciences sector in the UK, particularly London, and knowledge clusters around the world.

Firstly, this report discussed the UK life sciences landscape as reported by UK GOV reports and analyses conducted by research firms. We focused on five key areas that were relevant to KQ: life sciences in London, the talent, the finance and capital available in the life sciences, the role of data and the NHS. Overall, the UK is strongly placed to be an international leader in life sciences, but needs to focus on creating an incentivising environment for growth rather than just establishing.

Next, the approaches to the concept of knowledge clusters in three major regions – UK, EU and USA – were explored and compared. It was found that the EU emphasises collaboration between knowledge clusters throughout the region to develop a network. The UK vision aimed to boost innovation through knowledge clusters and facilitate the growth of SMEs and start-ups. Looking at USA, it was established that the policy environment allowed for private-sector led growth in developing densely strong knowledge clusters, which contrasted to the policies in the EU and UK.

Lastly, we created a database of around 250 relevant life sciences organisations in the KQ catchment area. This mapping aims to provide KQ with the base network to begin nurturing a bustling life sciences cluster based on our recommendations and internal research.

Recommendations

(1) **Networking opportunities and community building** are needed to encourage knowledge transfer across domains.
(2) **Partnerships within the education domain** can aid in achieving the UK Government's Vision by inculcating data skills and providing specific expertise to commercial businesses.
(3) Acting as **data hub** that allows knowledge transfer between the different actors in the life sciences industry can accelerate innovation.
(4) **Nurturing an environment for growth**, rather than focusing on an environment for starting, is needed in the life sciences domain, especially in London.
(5) **Collaborations need not be limited to within the KQ region**, but can be down across London and the UK.
(6) Utilise **digital innovations** to facilitate knowledge cluster building.

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