



THE DATA CITY

Greater Manchester Emerging Technologies Sectors Sensemaking & Narrative Report. “Your Digital HQ”

Client: MIDAS

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Introduction

[The Data City](#) is working with Greater Manchester Combined Authority (GMCA) and MIDAS (Manchester's Inward Investment Agency) to provide data and sensemaking relating to GM's tech profile. The project has two overarching aims:

1. Provide innovative new data sources for Greater Manchester's [prosperity review](#).
2. Use the data to create a marketing proposition for Greater Manchester's Inward Investment activity and identify target organisations for inward investment.

Overview

This document provides headline content with examples and sector summaries of our data. The data has been classified and visualised for MIDAS in the context of emerging technologies and inward investment for Manchester. It forms part of a suite of outputs that The Data City has provided for MIDAS using The Data City Organisation, Events and Research Data Assets.

The outputs are detailed in our report: *GMTech Profile, Compilation of Outputs, Summary Commentary*, Date: May 2019. A description of the data assets have been appended to this document: [Appendix A](#).

Context

Traditional methods of understanding economic and innovation activity struggle to reflect the evolving nature of the world around us. Innovation and emerging activity is hard to measure and SIC codes are poorly-suited to understanding the modern economy and how it is changing.

Current datasets struggle to fairly reflect:

- Large companies that span many industrial sectors,
- Technology companies which operate in small and frequently changing niches markets,
- Companies that operate in emerging sectors that have not yet been classified.

This report is based on a new experimental and still developing approach to understanding the Emerging Tech economy in Greater Manchester. It draws on a novel approach to analysis and categorising large datasets.

The data upon which the analysis is based has been generated by The Data City. It encompasses three areas of activity:

- **Businesses:** Data from Companies House has been augmented with information openly published on each company's website and analysed using a machine learning process to allocate businesses into emerging sectors. The base data for this element used in the GMCA prosperity review is available at Organisations Explorer. The more detailed analysis to identify inward investment targets is available in our target lists and PowerBI analysis completed with and for MIDAS.

- **Academic Papers:** Presents a classified ranking of academic publishing activity to capture the more formal base of innovation in the city¹. It uses the Open Project Academic Knowledge API which is part of <https://www.openacademic.ai/>. The base data for the element is available at Innovation Explorer.

- **Events:** Data drawn from Eventbrite and Meetup in the last twelve months has been analysed to try to reflect early stage innovation activity. Events have been classified against themes of interest using a machine learning process. The base data for the element is available at Events Explorer.

This represents a new way of measuring economic activity and should not be used to compare specific numbers against official statistics. The process relies on rounds of iterative learning which are still on-going and which will generate additional perspectives.

The approach uses machine learning to classify businesses based on the words they use to describe themselves. The first step is for a relatively small number of websites and businesses, which the team are confident to say represent a sector or area of interest, to be manually classified. This initial dataset is then used to train a machine-learning algorithm to identify similar businesses. The dataset will be further updated as examples of mis-categorised businesses are flagged up. This iterative approach will over time generate much improved datasets on which more confident insights can be based.

The quantity of papers published by city and number of citations to papers published and patents filed has been included to show the quantity and quality of research within a given city. Research begins with building familiarity with what has gone on before, it is the process of incremental improvement of the understanding of the scientific community. Academic institutions value authenticity and researchers strive to deliver high-impact, quality research, which is often difficult to measure, thus citations are often used as a proxy.

MIDAS has also completed analysis of skills data sourced from LinkedIn which is available separately to this report.

Approach

Our work with GMCA looked across eighteen sectors and broad indicators of innovation and emerging technology that are not identified in traditional economic research – particularly when SIC codes are used to classify business activity.

The work with MIDAS focused on a narrower field of eight emerging technology sectors and aimed to identify specific organisation targets for inward investment in Manchester.

In both cases we augmented the research on organisations with data relating to academic research and events activity. This data is the same for the GMCA and MIDAS outputs.

In this report we have used the data and outputs from each to present and interpret the data in the context of emerging technology and inward investment for Manchester. The Data City created two separate, different but related data assets and queries relating to organisations, addressing the linked but different objectives of GMCA & MIDAS, i.e. a broad assessment of the size of a wide number of sectors of interest (GMCA) and a detailed assessment of eight emerging technology sectors (MIDAS) with associated targeting of inward investment target organisations.

In simple terms the data and approach used to power our organisation explorers is derived from the work The Data City completed with GMCA for the prosperity review. A separate data asset has been created for the MIDAS emerging technology sectors and targeting activity for MIDAS.

The process of targeting potential inward investment targets for MIDAS uses the The Data City Data Assets, combined with business intelligence tools (PowerBI) and supporting desk based research. An initial long list of targets is created by The Data City which identifies digital businesses in the UK, each of these businesses required individual research to establish whether the business would be suitable for Manchester's digital economy.

Businesses which are suitable for Manchester and are not already in Manchester or the digital part of the business is not in Manchester along with other specific criteria from MIDAS e.g. if contact has already been made or intelligence is available to say contact should not be made.

Suitable targets were then segmented into the employee size and/or GMCASIC Grouping in order to meet the total number of target requirements for MIDAS. The most suitable business were subsequently added to a shortlist and checked over by one of MIDAS in house team to create a refined list which combines experience from The Data City and MIDAS.

In parallel with this project and using many of the same techniques, The Data City has published the UK Tech Census at this [link](#).

The UK Tech Census measures the strength of UK city economies in emerging and digital technologies. It then places Manchester in context in the UK and uniquely provides us with real-time consistent data enabling us to make real comparisons across the UK.

We present our commentary on headline insights from this work in the report attached. It provides an analysis of emerging technology fields and themes across the UK economy - you can download the report at this [link](#). The data has been visualised and presented and you can access the interactive explorer tools at this [link](#).

Manchester Emerging Sectors and Themes Matrix

Using The Data City's data on organisations, papers and patents, and events we searched for sectors where Greater Manchester overachieves. The boundaries used in this report have been standardised by the OECD. For more information on these boundaries see: [ODI OECD12](#) and [OECD](#).

We have identified eight strengths of Greater Manchester that are consistent and statistically significant across all or most of our datasets.

	Organisations	Papers and patents	Events
Service Design	✓ top outside of London user experience, customer journey, PaaS	✓ top outside of London very strong in: marketing, commerce, advertising some strengths in: user experience, service design.	✓ top outside of London very strong in: service design, digital service, user experience, customer journey
Advanced materials	✓ top outside of London Composites, integrated manufacturing, advanced materials and graphene	✓ world leading world-leading in: graphene, materials science, composite material, alloy, corrosion, welding, aluminum very strong in: control engineering, operations research	✓ top outside of London (though there are few events anywhere) graphene, advanced materials
Ecommerce	✓ top outside of London AdTech, E-commerce, Marketing, Online payments	✓ top outside of London very strong in: marketing, commerce, advertising.	✓ top outside of London e-commerce
AI & Data	✓ top outside of London AI, data analytics, artificial intelligence, machine learning, deep learning	✓ top outside of London very strong in: Data collection, data mining, data science, ontology, information systems some strengths in: artificial intelligence	✓ top outside of London very strong in: data science, data analytics, AI, and Artificial Intelligence
Cyber	✓ top outside of London Cyber Security, Cyber, Crypto	✓ top outside of London very strong in: cloud computing, information technology, server some strengths in: computer security	✓ top outside of London very strong in: cyber, cyber security, and crypto
Construction tech	✓ top outside of London BIM, Building information, innovative building, district heating, sustainable building, innovative construction	✓ top outside of London very strong in: engineering management some strengths in: structural engineering, sustainable development	✓ 5th in the UK (though there are few events anywhere) BIM, Building information, Offsite construction, Sustainable building
Internet of Things	✓ 3rd, behind London and Reading Internet of Things, Sensors	mixed. some strengths in: embedded systems, wireless sensor networks but not UK-leading or world-leading.	✓ top outside of London internet of things, sensors
MedTech	✓ top outside of London Medical technologies, medical instruments	✓ top outside of London very strong in: medical physics some strengths in: advanced materials engineering related to medical technologies innovation are listed under advanced materials	✓ 5th in the UK (though there are few events anywhere) medical tech events are stronger in London, Cambridge, and sometimes York, Birmingham, and others

Note: This table has been presented in no particular priority or ranking order.

Since our data looks at: the total number of organisations, the total number of published papers and patents, and the total number of events, it is almost inevitable that London tops these tables since we are looking at total count. For this reason, often London is ignored and we draw a comparison between the rest of the UK.

Greater Manchester Headlines

Using its unique dataset, The [Data City](#) has completed analysis of the emerging technologies landscape in Manchester and made comparisons across the UK in terms of organisations and events and made global comparisons in terms of academic activity.

The data shows that:

- a. Manchester is clearly the UK's second technology city. The data relating to organisations shows that it outperforms all cities outside London, in all of the areas of emerging technologies referenced in this report. This is across the board, not only in the individual sectors, which means that Manchester's emerging technologies sector is broad and deep and could arguably be ranked first if we considered cost factors such as property and cost of living.
- b. Our data demonstrates that Manchester is world leading in advanced material and is the top ranked city outside London in 5 of the 8 sectors we have classified across all domains of organisations, research & events i.e.
 - i. Advanced Materials - world leading research capability and top outside London for organisations & events.
 - ii. Top outside London - Service design, eCommerce, Cyber, AI & Data Science.
 - iii. The research demonstrates that Manchester is producing trained graduates in the disciplines that the emerging technologies sectors demand.
- c. When you consider the number and comparable research institutions in London, the relative levels of government investment and overall imbalance of investment towards London, arguably Manchester is punching way above its weight.
- d. The events data shows that the Manchester digital data & technology eco-systems are established and functioning at a level above all other cities in the UK except London. We have significant evidence of user groups and technology meetups for all aspects of the emerging tech system. This clearly demonstrates Manchester's collaborative environment which is an essential ingredient for successful emerging technologies sectors and businesses to thrive.
- e. The data provides confirmation and evidence of acknowledged strengths - e.g. eCommerce and Advanced Materials, we now have a deeper understanding of these sectors their strengths, research, eco-system and the depth of the sector proposition.
- f. The attached sector summaries provide details but in simple terms we now have data to support the acknowledged strengths and create additional inward investment.
- g. We have clear evidence to demonstrate that in the emerging sectors and growth sectors of the future e.g. Cyber, AI and Data, Service Design, Construction Tech, MedTech - Manchester has a broad and deep capacity and capability.

- h. The data provides us with evidence that Manchester is at the forefront of disrupting traditional manufacturing, construction and product & service design. The data is provided in the Service Design, Construction Tech and MedTech sector summaries.
- i. The fact that the data demonstrates Manchester's broad and deep capacity across the emerging technologies sectors classified by The Data City, and the fact that technology is a cross cutting theme that is disrupting all traditional sectors means that we can expect that Manchester will prove to be a leading centre for technology disruption in other traditional sectors.

Our work with MIDAS and the research & data that The Data City has completed, demonstrates with data that Manchester is where the emerging technologies sectors are present and emerging, and are significant on a national and international scale.

Manchester is and will become increasingly the place to establish your emerging technologies business or your digital or technology HQ.

"Manchester is your Digital HQ".

The Data City

October 2019.

Service Design

Introduction

Our work analysing 500 thousand technology events, 200 million scientific papers and patents, and 3.8 million web presences of UK registered companies has surfaced a significant strength of Greater Manchester, service design.

Service design as a research field emerged from studies of advertising and business management and has matured today into an increasingly widely used process for changing a business, often using technology, to relentlessly focus on customer needs and desires. The transition is often accelerated by a need to embrace eCommerce and move sales by advertising online.

Why is Service Design important to Manchester?

Service design encompasses all the disciplines that the digital economy is using to build the services of the future and drive the exciting digital transformations that we know are happening to all parts of the economy.

The data shows that Manchester has significantly more academic papers on service design innovation and eCommerce published than in any other UK city outside London.

There are also more than twice as many tech events on the topic of “service design”, “ethics in technology”, and “tech for good” held in Manchester than in any other city outside London.

Organisations

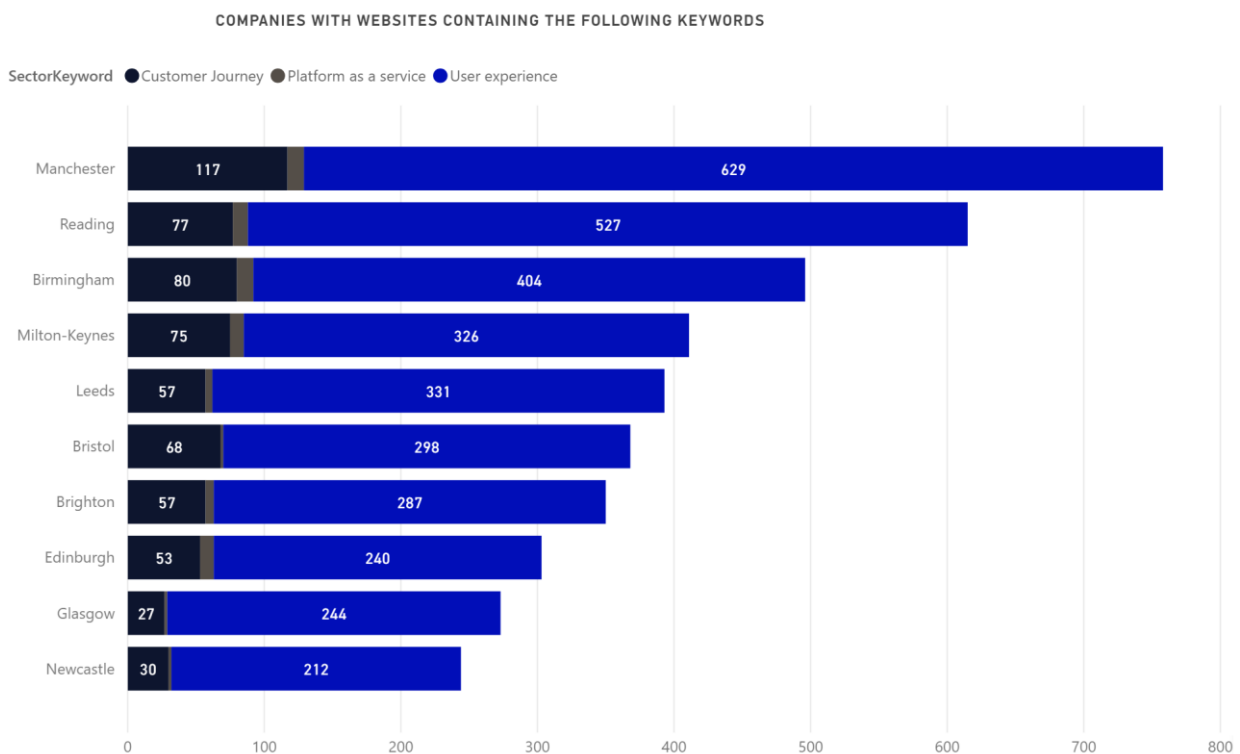
In early 2019 The Data City reached a key milestone; successfully classifying, using machine learning and AI, over 1 million UK organisations into their relevant industries.

- **¹Manchester ranks second in the number of organisations that have been classified as Service Design (8,051),** only 400 organisations behind Brighton (8,402).
- **²Manchester is the top ranked city for organisations websites which contain keywords that relate to service design.** Manchester has around 750 different organisations. Reading is second to Manchester with 615 organisations.
- Of the 629 organisations which include the keywords 'user experience', **Manchester ranks highest of those which include 'Innovation' (~67%) and recruitment (~61%).**

Keyword Data Visualisations

When we look closer at the Service Design landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by organisations involved in Service Design.



Supporting Desk Based Research

Our data shows that all the component parts of service design, which for non-digital sectors and companies means digital transformation are here in Manchester.

¹ Using the Data City's machine learning classification, [grouping by Creative, Cyber and Advanced Digital](#), outside of London.

² Using the Data City's keyword data visualisations which consider keywords in companies' websites, outside of London. Keywords used: User Experience, Platform as a Service, Customer Journey.

Crucially these companies and organisations are varied in both background and size.

We have provided detailed data relating to these companies in the data sets provided to MIDAS and short initial commentary below.

Stride Treglown are a Bristol-headquartered architecture and planning firm, but have embraced service design principles and grown [their digital design team](#) in Manchester. Even Manchester's governments are embracing the city's world-leading strength in service design to pull ahead - Stockport council were able to avoid outsourcing their new website and easily assemble a team from the talent available in the city. By engaging with the service design events and business ecosystem they produced an award-winning [new website](#) that is now being re-used by other local government.

From local government to architects and planners Manchester's service design strength, with key players such as The Co-Op Group and the region's universities underpinning and supporting it, is something that few other cities can offer.

Manchester's standout example in service design is The Co-operative Group. In 2015 they moved first among traditional retailers to embrace service design as a path to deep-rooted growth. They started by [hiring much of the team](#) behind the world-acclaimed re-organisation of UK government digital services. The company's success is well known, the [co-op's service design blog](#) is a widely respected example in the industry, and their allied tech accelerator and events space at [The Federation](#) is a hub for service design companies small and large.

But The Co-op group are not alone. More companies in Manchester have a web presence talking about "user experience", a keyword associated with service design, than any other city outside of London.

Research

The Data City's Data demonstrates that, outside of London, Manchester is delivering a substantial amount of research in marketing, observational study, qualitative research, user interface and advertising.

- ³**Manchester publishes the most papers with keywords which relate to Service Design.**
- ⁴In relation to the total number of citations to papers published and patents filed in Service Design, **Manchester ranks the top city, where it has recorded almost 140,000 different papers in total.**
- These research strengths feed into availability of graduates to fill service design roles in companies undergoing internal digital transformations to adapt to new customer expectations.

One of the world's leading researchers on service design and its impact on industry is Prof. Bruce Tether at The Manchester Institute of Innovation Research at Manchester University. He is also the Associate Head of Research for the Innovation Management and Policy Division within MBS, and a member of the Executive Board of the UK Innovation Research Centre (UK-IRC).

For a company considering relocation, the strength of research and training in fields related to service design at institutions across the city region, should be of interest too. The Data City's key takeaway is that Manchester has lots of ideas and lots of talented people working on innovation in service design.

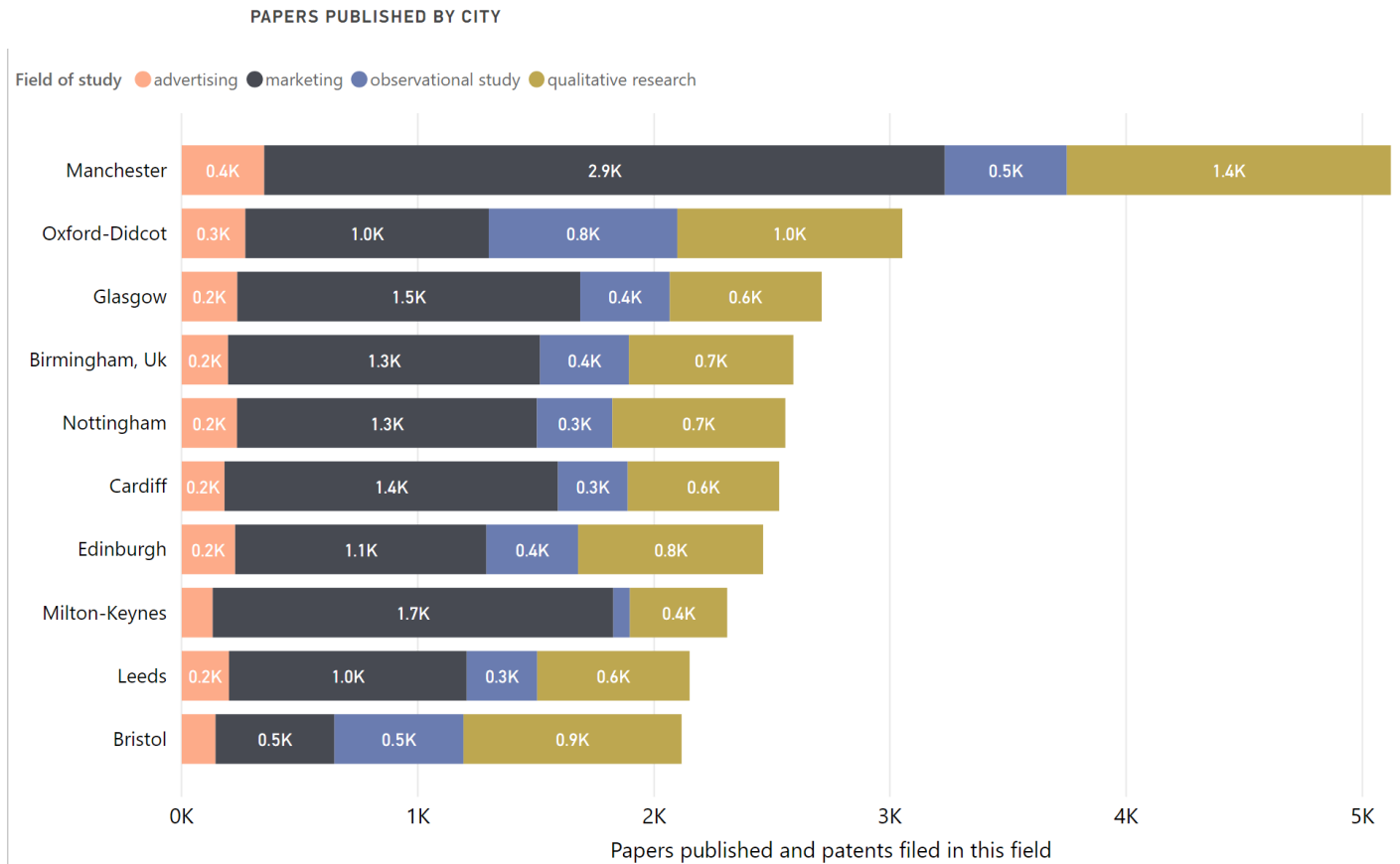
³ Outside of London, when considering the The Data City's keyword data asset. Keywords: (advertising, marketing, observational study and qualitative research).

⁴ Using The Data City's keyword data asset (using keywords: advertising, marketing and user interface).

Keyword Data Visualisations

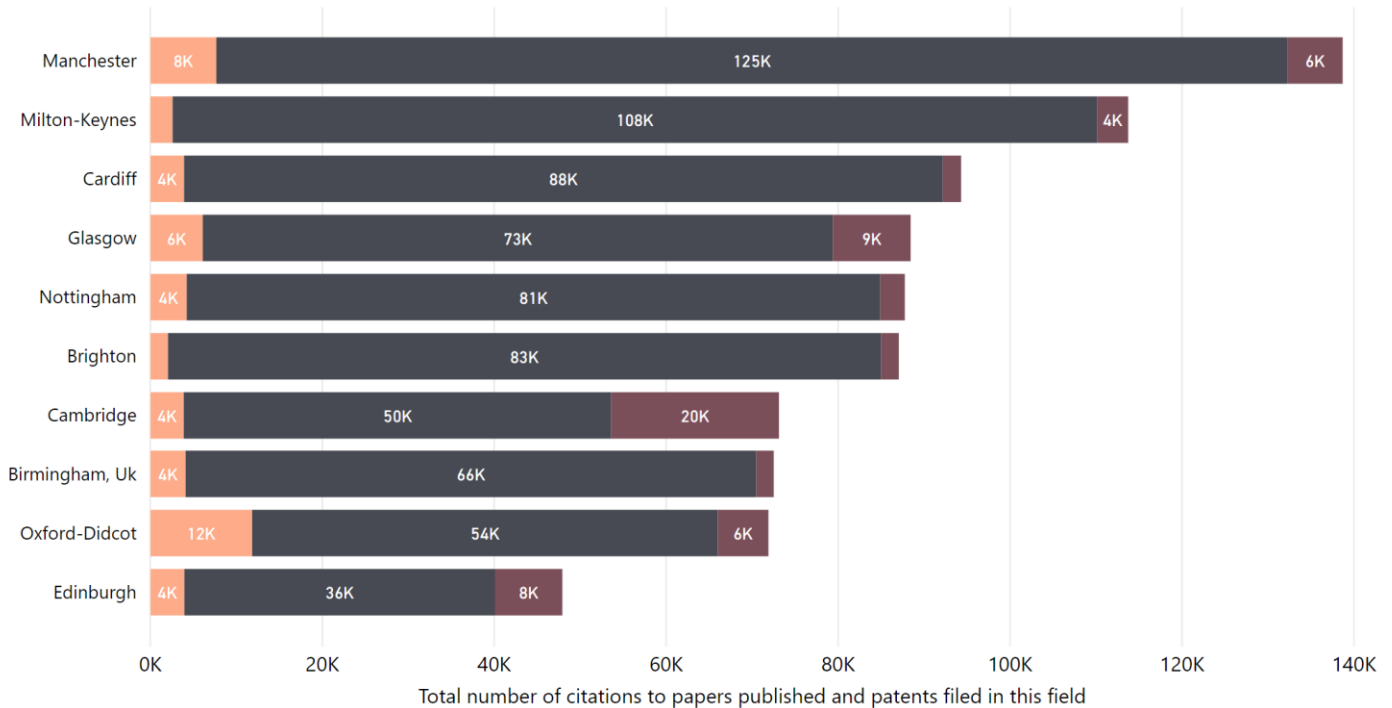
When we look closer at the Service Design landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by research surrounding Service Design.



CITATIONS TO PAPERS PUBLISHED BY INSTITUTIONS IN EACH CITY

Field of study ● advertising ● marketing ● user interface



Supporting Papers

Highly cited papers and books from researchers in Manchester include:

- Namoun, A., Nestler, T., & Angeli, A. D. (2010). Conceptual and usability issues in the composable web of software services. In ICWE'10 Proceedings of the 10th international conference on Current trends in web engineering (pp. 396–407).
- Tether, B. S. (2014). Services, Innovation, and Managing Service Innovation. In: Mark Dodgson, David Gann, Nelson Phillips, Editor(s). The Oxford Handbook of Innovation Management. Oxford: Oxford University Press; 2013.
- Chang, Y.-C., Miles, I., & Hung, S.-C. (2014). Introduction to special issue: Managing technology-service convergence in Service Economy 3.0. *Technovation*, 34(9), 499–504.
- Barnett, W., Foos, A., Gruber, T., Keeling, D. I., Keeling, K., & Nasr, L. (2016). Re-examining Value Co-creation in the Age of Interactive Service Robots. In 2015 Academy of Marketing Science World Marketing Congress (pp. 417–422).

Events

Our data shows that all the component parts of service design, which for non-digital sectors and companies means digital transformation are here in Manchester – whether they be product designers, web developers, content & creative specialists, IT & operations specialists, data & data science, ethics & tech for good practitioners; people and organisations are here in Manchester, within the most vibrant technology and digital ecosystem outside London supported by leading academic research and activity. And when you consider the size of Manchester, the density of this activity and value is equivalent or greater than any other city in the UK.

The buzz around service design in the city is clear in the data on tech events. A new employee at a company looking to learn, or a senior member of staff looking to get ideas about service design, could easily attend a small event on the topic, advertised publicly on Meetup or Eventbrite. There is one of these events, typically run by experts working in the field and sharing ideas in the open, nearly every week in Manchester; **over double the rate of the nearest competitor city in the UK outside of London, Bristol.**

- **⁵Manchester is recording 1153 events hosted on *Eventbrite* and *Meetup* since January 2018 which are related to Service Design.** Only Edinburgh and Bristol record similar figures, 1056 and 1004 respectively.
- **Last year over 109 events were held on service design (more than one per week) and Manchester is the top ranked city⁶,** almost double the next most active city Bristol. High profile national events such as [NUX8](#) were held in Manchester.
- **In a combined count of papers published in advertising, marketing, observational studies, and qualitative research, Manchester comes second only to London among major European cities,** and ahead of much larger cities like Paris and Amsterdam.

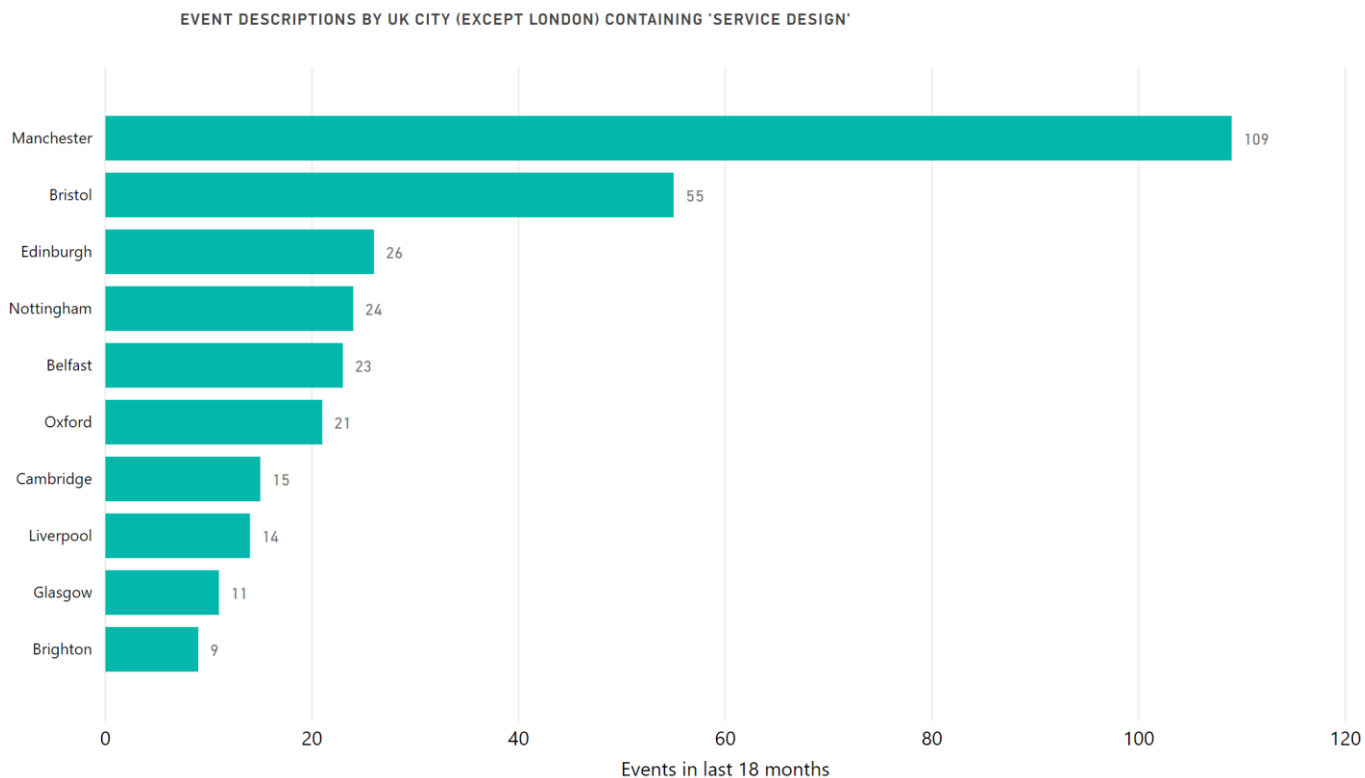
⁵ Using data supplied from [The Data City's event explorer](#), considering key classifications such as Creative and Digital.

⁶ Outside of London.

Keyword Data Visualisations

When we look closer at the Service Design landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by events surrounding Service Design.



Examples

Huge events like [NUX8](#) (a UK national user experience & design conference) are regular fixtures in the city and relocations such as Booking.com's recent move to the city show how attractive this is to companies with a sharp and public focus on user experience and service design.

Advanced Materials

Introduction

Our work analysing 500 thousand technology events, 200 million scientific papers and patents, and 3.8 million web presences of UK registered companies has surfaced a significant strength of Greater Manchester — Advanced Materials.

Manchester is a world-leader in developing new and existing materials for extreme environments. It also leads the world in the characterisation of materials – measuring and exploring materials that will help us fully understand their properties and potential. Manchester is also at the forefront of biomedical materials, as well as new materials designed to serve the nuclear energy sector.

Manchester's world-class status is not only the birthplace of graphene but also the centre of its international commercialisation.

Why is Advanced Materials important to Manchester?

University of Manchester is a critical central player within the Advanced Materials sector and ecosystem - they provide a [detailed explanation](#) which clearly demonstrates why Advanced Materials are important and why they are important for Manchester. Examples include the likes of developing graphene and improving the safety of aero engines. With the construction market being one of the largest in the world, the industry continues to develop, looking for materials to enable innovative designs for projects or to offer novel solutions to challenge industry specifications and standards.

Organisations

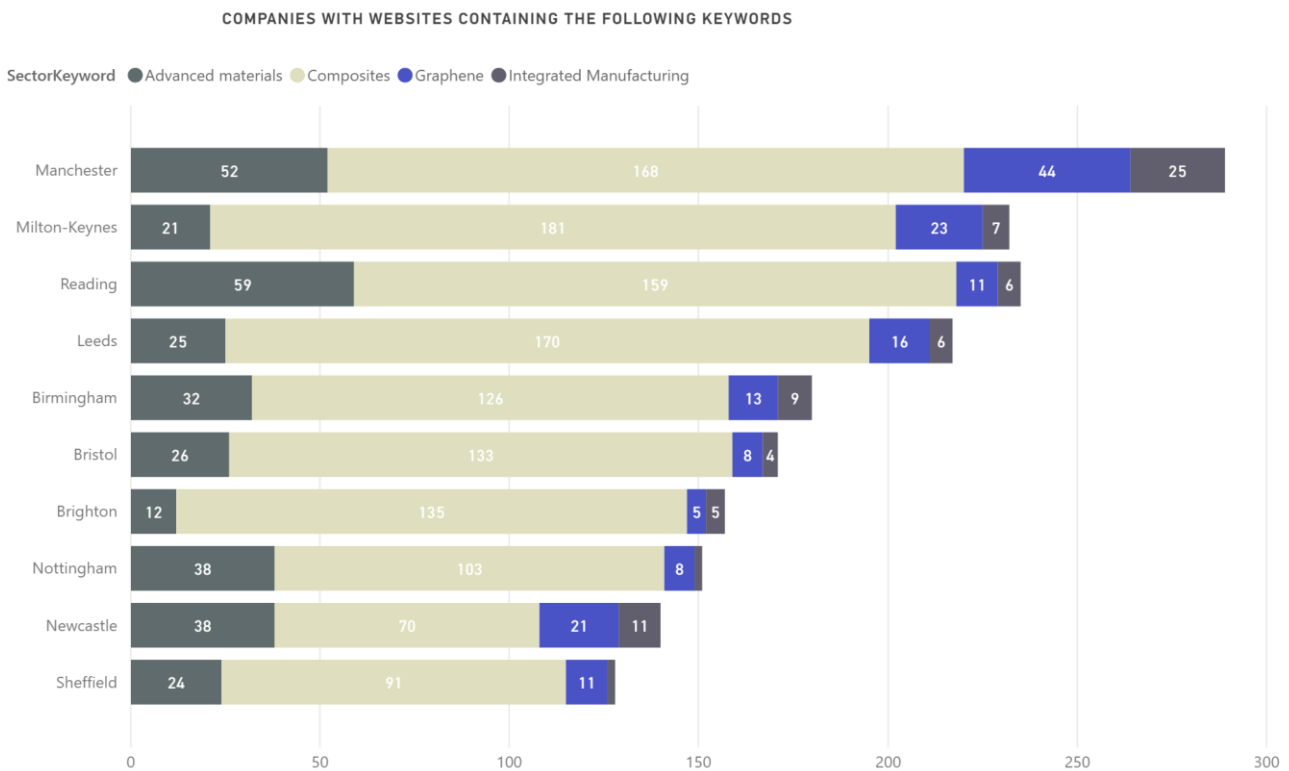
In early 2019 The Data City reached a key milestone; successfully classifying, using machine learning and AI, over 1 million UK organisations into their relevant industries.

- ⁷**Manchester is ranked the top city in the UK with almost 300 organisations with websites containing keywords related to Advanced Materials.** This is around 50 more than the next top ranked city (Reading).
- **Of the 168 organisations which mention the keyword 'Composite', 91.1% of organisations describe themselves as 'Original' and 75.4% of organisations describe themselves using the keyword 'Concept',** thus highlighting Manchester's strengths in innovation and ideas.

Keyword Data Visualisations

When we look closer at the Advanced Materials landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by organisations involved in Advanced Materials.



⁷ Using the keyword data visualisations provided by The Data City, when considering keywords associated with Advanced Materials (Advanced Materials, Composites, Graphene and Integrated Manufacturing).

Supporting Desk Based Research

When searching for companies within Greater Manchester that are heavily invested in Advanced Materials, it is difficult to avoid the impact the investment in Graphene has had. In September 2013, [BGT](#) announced plans to [collaborate with Manchester University on several graphene projects](#). BGT was the first industrial partner of the £60million National Graphene Institute at the University of Manchester. Since then, BGT has spun off into another company, [Graphene Lighting](#). Other companies include [Hydratron](#) which is a global leader in the manufacture of high pressure liquid pumps and gas boosters. Manchester's material sector is a close third with respect to composite materials however when organisations which host graphene and Integrated Manufacturing, Manchester is the number one city outside of London. The National Graphene Institute is spinning off businesses based on products born out of the University's portfolio of 2D materials technology patents – principally graphene. Other notable examples include [graphene-enabled](#) which bridges the gap between the high-quality 2D materials research being carried out at the University and the commercial needs of industrial companies that would gain from using these technologies in their products.

Research

The Data City's data demonstrates that, outside of London, Manchester is delivering a substantial amount of research in graphene, materials science, composite material, alloy, corrosion, welding, aluminium and is very strong in control engineering and operations research.

- **⁸Considering the volume of research in graphene, Manchester is the [top ranked city in the UK](#).** Manchester has recorded 631 papers related to graphene, a third more than second place Cambridge (430).
- **⁹Manchester is the top city outside of London ranked by the quantity of papers published in Advanced Materials.** Around 25,000 papers have been published in Advanced Materials; compared to the second ranked city Birmingham with only ~21,000 papers published.
- **The University of Manchester hosts one of the most highly cited researchers (in 2014), Sir [K. S. Novoselov](#), where he is one of the directors of the National Graphene Institute.** His work on graphene with Andre Geim earned them the [Nobel Prize in Physics](#) in 2010. Researchers within Manchester Metropolitan University have ties with Central South University which specialises in Alloys and Compounds and the Transactions of Nonferrous Metals.

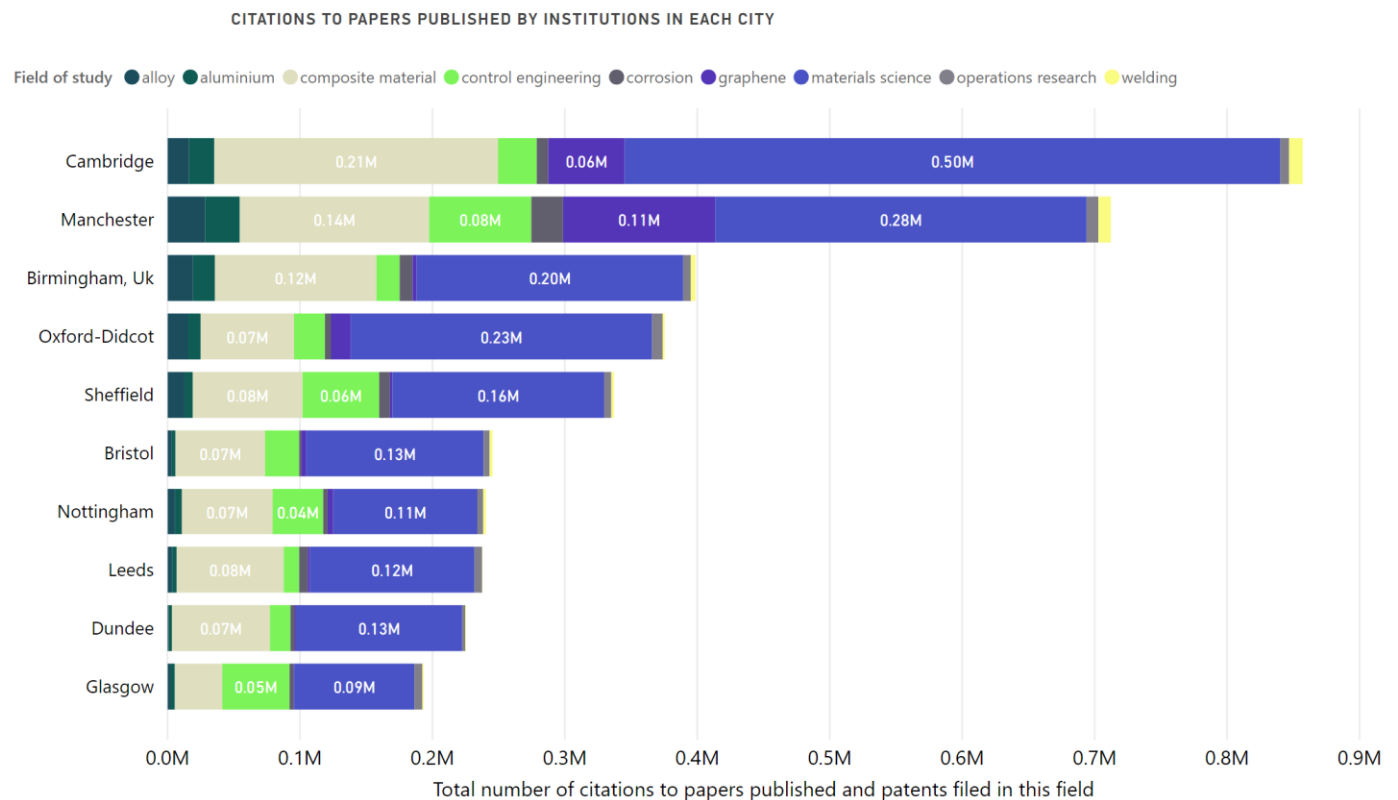
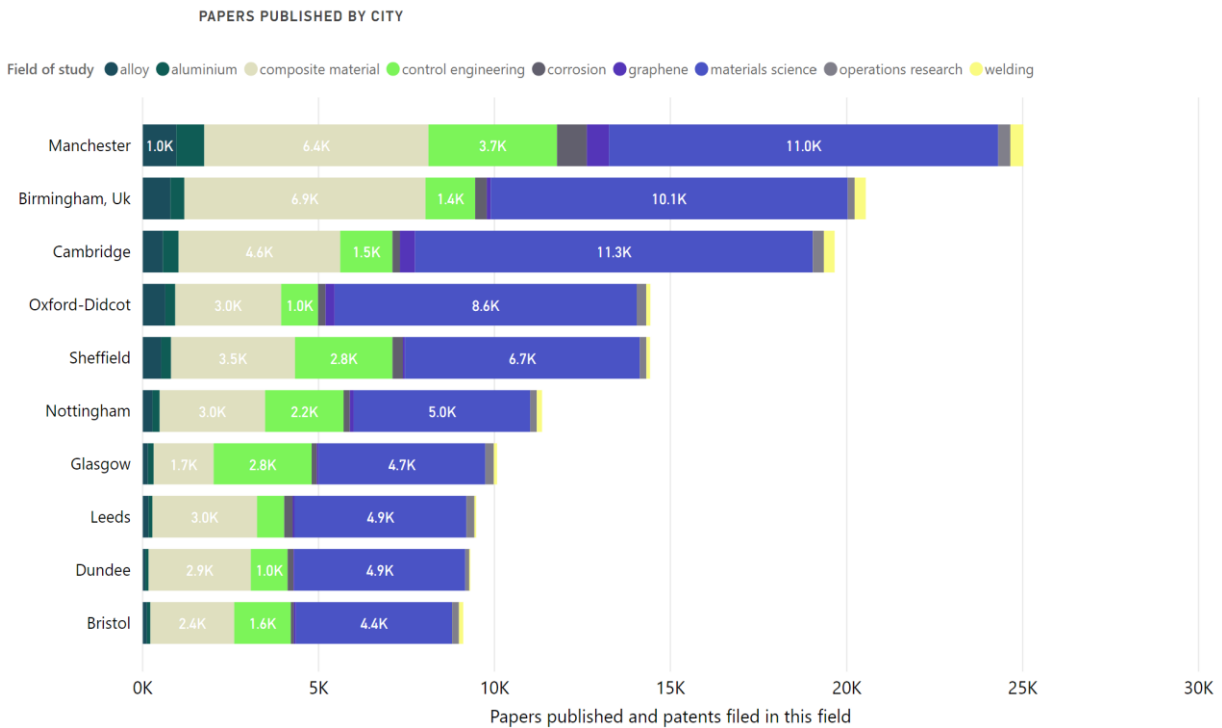
⁸ Using The Data City's innovation explorer, outside of London.

⁹ When specifying keywords related to Advanced Materials and using the data visualisations supplied by The Data City.

Keyword Data Visualisations

When we look closer at the Advanced Materials landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by research surrounding Advanced Materials.



Supporting Papers

Novoselov, K. S., et al. "Two-Dimensional Atomic Crystals." *Proceedings of the National Academy of Sciences of the United States of America*, vol. 102, no. 30, 2005, pp. 10451–10453.

Schedin, F., et al. "Detection of Individual Gas Molecules Adsorbed on Graphene." *Nature Materials*, vol. 6, no. 9, 2007, pp. 652–655.

Hou, Hongshuai, et al. "Carbon Quantum Dots and Their Derivative 3D Porous Carbon Frameworks for Sodium-Ion Batteries with Ultralong Cycle Life." *Advanced Materials*, vol. 27, no. 47, 2015, pp. 7861–7866.

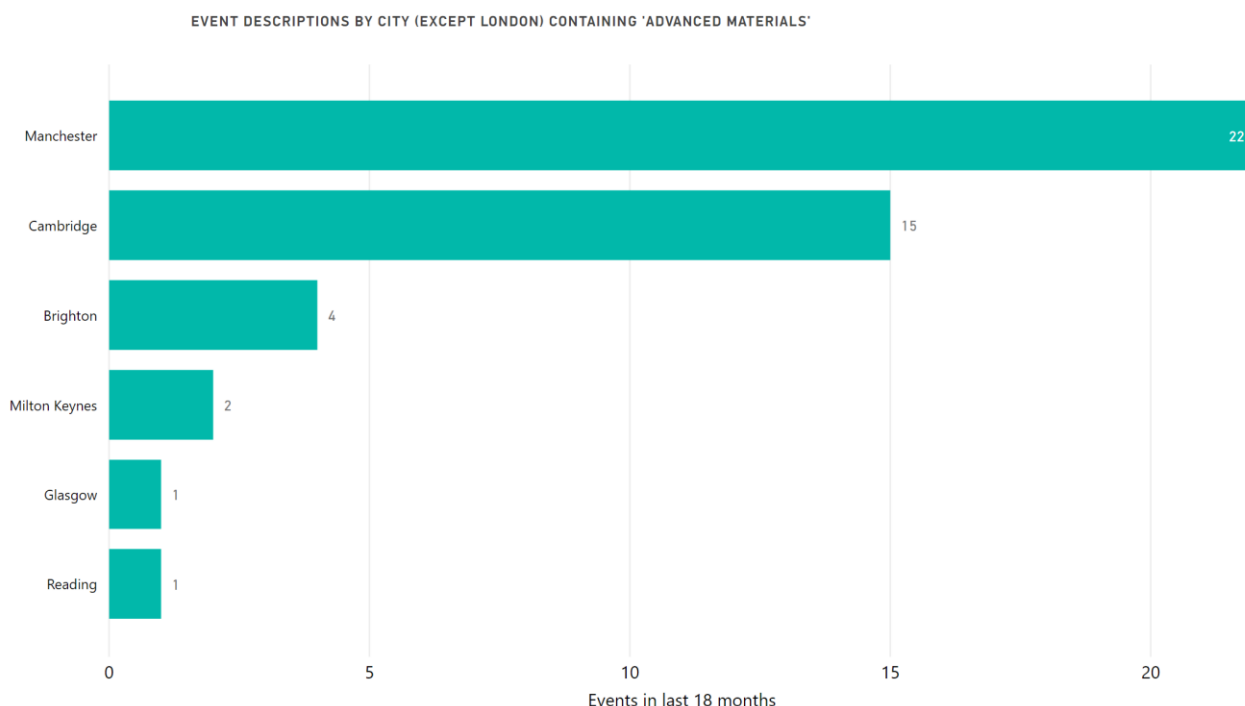
Events

- ¹⁰ Manchester is ranked the top city hosting events with descriptions containing 'Advanced Materials' or 'Graphene'.
- ¹¹ Manchester is [hosting the most events](#) which are classified as Manufacturing in which Advanced Materials play a key part. Manchester has hosted 521 Manufacturing events hosted in *Eventbrite* and *Meetup* since January 2018.

Keyword Data Visualisations

When we look closer at the Advanced Materials landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by events surrounding Advanced Materials.



Examples

There is limited scope in which events involving Advanced Materials are hosted due to the nature of the search terms. However, the University of Manchester hosts the [Graphene Hackathon](#) and there is a [Graphene Networking opportunity](#) which is a regular meeting with 30 plus business owners from within the city centre and surrounding areas. The [Graphene Engineering Innovation Centre](#) is looking to host the first hackathon in November, where teams will compete to develop and prototype innovative products using conductive [graphene](#) inks. This will be the world's first Graphene Hackathon.

¹⁰ Due to the nature of advanced materials and keyword searching it is relatively difficult to identify events which are based on advanced materials however using The Data City's keyword data visualisation.

¹¹ Using the GMTech profile supplied by The Data City.

eCommerce

Introduction

eCommerce is growing at an unprecedented rate all over the world due to the increased connectivity in each consumer possess. The increased usage of the web, increased ownership of a smartphone with upgraded speeds, increased network coverage and faster online payments are all positively contributing to a cultural shift in primarily shopping online. The rise in using AI within eCommerce is helping to understand the differences between each consumer when choosing to shop on their site, there is a cultural shift towards the web.

Why is eCommerce important to Manchester?

Retailing is now an online activity, increasingly on mobile devices, supported by the physical infrastructure of shops, warehousing and delivery services. All of which is underpinned with and by data.

Manchester is an eCommerce powerhouse and will be where the innovation, development and deployment in eCommerce happens. This is demonstrated in data provided by The Data City, supported by Manchester's long industrial and institutional retail and technology history and confirmed by the presence of The Co-Op, Manchester Metropolitan University and eCommerce leaders such as: BooHoo, AO.com, underpinned by the recent establishment of Amazon.

Market research shows a wide variety of [CTOs and CMOs](#) like Manchester for its expertise in retail and manufacturing, specifically Manchester has some high-profile retail brands and there is a growth in eCommerce and technology companies. Manchester is a major European eCommerce hub with numerous home-grown global companies, there is a clear history of innovation in this space.

Organisations

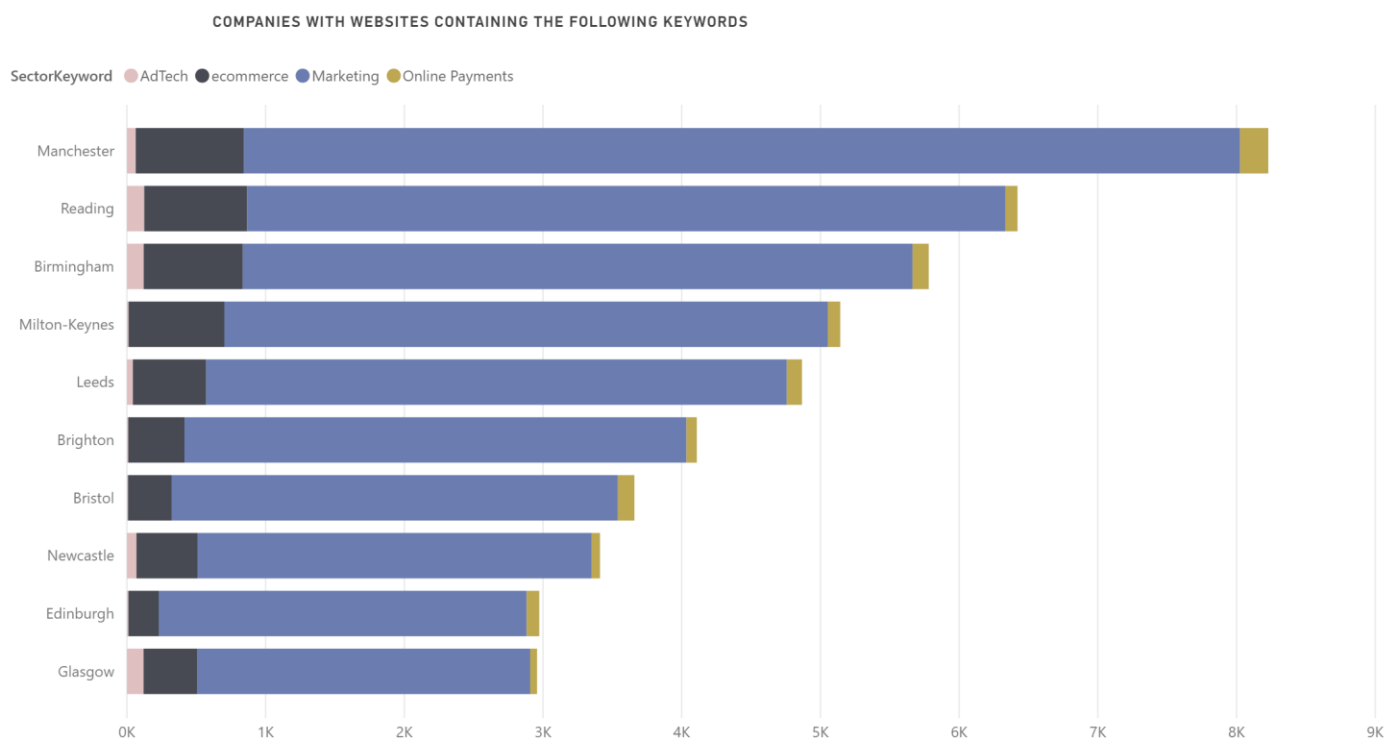
In early 2019 The Data City reached a key milestone; successfully classifying, using machine learning and AI, over 1 million UK organisations into their relevant industries.

- ¹²**2863 organisations have been classified as eCommerce organisations based in Manchester making Manchester the top ranked city in the UK.** It is over 1000 organisations more than the next city which is Birmingham with 1790 organisations.
- ¹³**Manchester ranks first with the total amount of companies (8,200) that include keywords related to eCommerce**, over 1500 more than the second ranked city (Reading, 6400).
- Of the total 8200 organisations, **54.1% include the keyword 'recruitment', 53.2% include the keyword 'growth' and 49.6% include the keyword 'innovation'.**

Keyword Data Visualisations

When we look closer at the eCommerce landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by organisations involved in eCommerce.



¹² Using The Data City Tech Census 2019 [explorer](#), outside of London.

¹³ Outside of London, keywords used: AdTech, eCommerce, Marketing and Online Payments.

Supporting Desk Based Research

Desk based research completed by The Data City has identified the following organisations to support the data presented in this report.

A key example is The [Hut Group](#) which has grown from 50 people in 2011 to 5,000 in 2019. The Hut Group have taken 1 million sq. ft of office space at Manchester Airport to build a new campus and are investing \$1bn in Manchester over the next 3 years ultimately supporting up to 10,000 jobs. The project represents the UK's largest bespoke office development outside London.

Organisations such as [Ecomnova](#) originally set up in London but have ventured for digital expertise in Manchester. Ecomnova have built a retail marketing platform which enhances user experience personalisation, user tracking and optimisation using a blend of open source & proprietary technologies alongside 3rd party platforms.

In Greater Manchester, [lawDigital](#) have supported the development of eCommerce site and local business [FitChef](#), their expertise allowed the client to request unique features, high end design and Search Engine Optimisation (SEO) on a moderate budget. One of the most prolific eCommerce businesses located in Manchester is [NBrown](#), where 84% of its £432.9m income now comes from eCommerce. NBrown is utilising eCommerce technology to help scale its delivery capabilities. As shown by the two graphs below, Manchester is the top city outside of London which is using marketing effectively to boost the quantity of online payments in eCommerce.

Research

The Data City's Data demonstrates that Manchester is delivering a substantial amount of research in marketing, [eCommerce](#), and advertising.

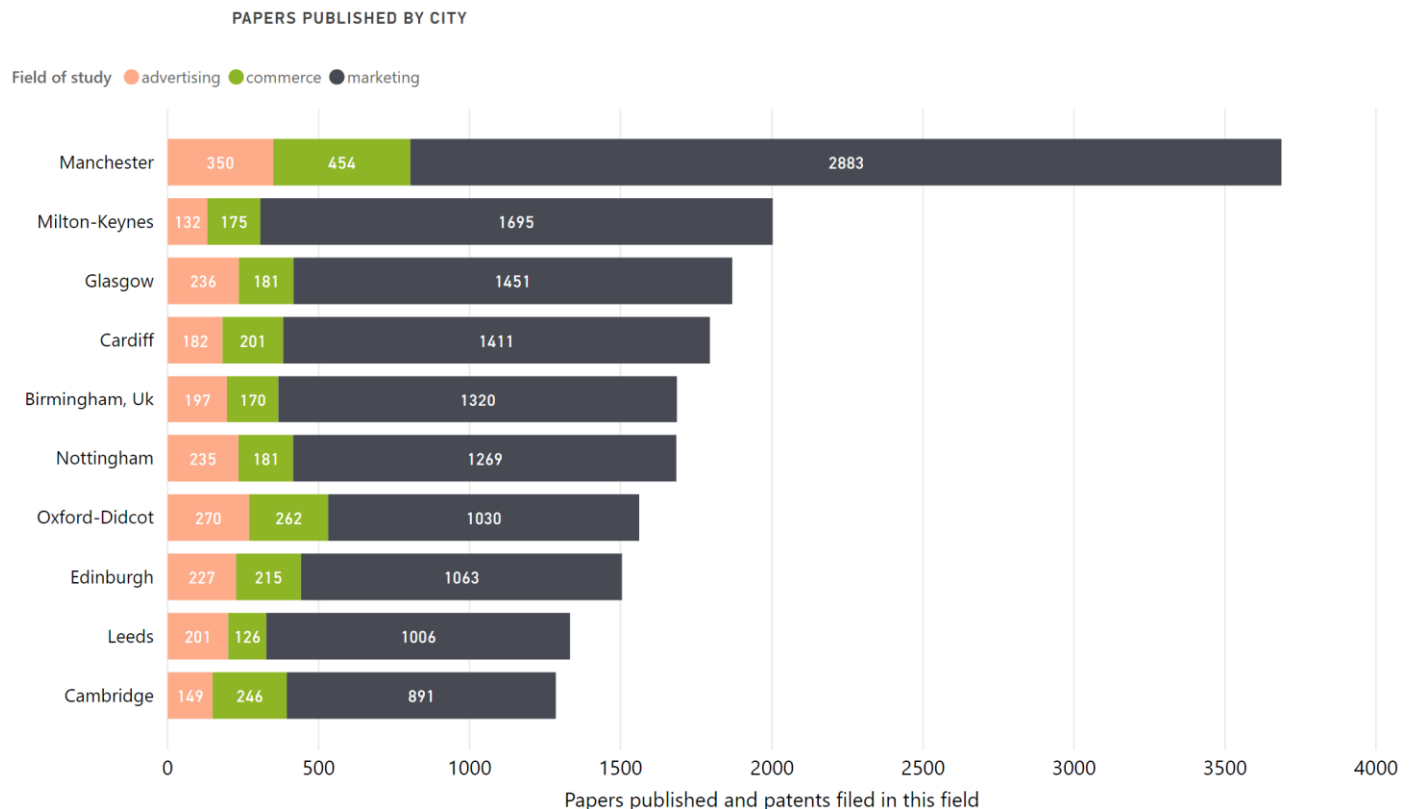
- ¹⁴**Advertising, eCommerce and Marketing combined have nearly double the amount of papers published in Manchester compared to every other city in the UK**, however with fewer research institutions compared to London it is arguably competing favourably.
- ¹⁵**Manchester is ranked first in the total amount of citations to papers and patents filed in the fields related to eCommerce**, around 150,000. This is almost 30,000 more than the second most city, Milton Keynes.
- **In 2005, Molla, Alemayehu, and Paul S. Licker released a paper which has been cited over 550 times.**

Comparing citations to papers published by institutions, Manchester is leading the way. A substantial portion of advertising papers produced by the University of Manchester are regularly presented in [International Journal of Electronic Commerce](#).

Keyword Data Visualisations

When we look closer at the eCommerce landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by research surrounding eCommerce.

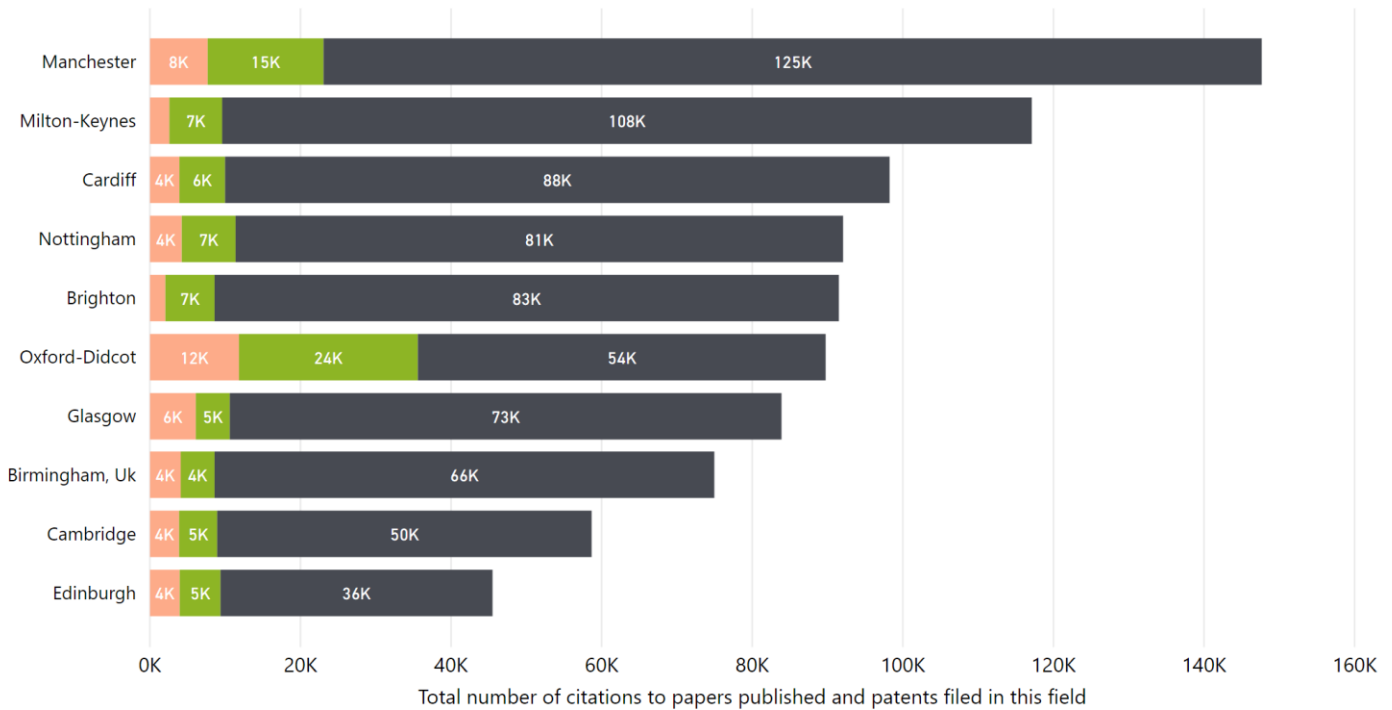


¹⁴ With the exception of London.

¹⁵ Using the keyword data visualisations supplied by The Data City.

CITATIONS TO PAPERS PUBLISHED BY INSTITUTIONS IN EACH CITY

Field of study ● advertising ● commerce ● marketing



Supporting Papers

Molla, Alemayehu, and Paul S. Licker. "ECommerce Adoption in Developing Countries: A Model and Instrument." *Information & Management*, vol. 42, no. 6, 2005, pp. 877–899.

Shah, Syed Zulfiqar Ali, et al. "Advertising, Earnings Prediction and Market Value: An Analysis of Persistent UK Advertisers." *British Journal of Management*, 2019.

Blázquez, Marta. "Fashion Shopping in Multichannel Retail: The Role of Technology in Enhancing the Customer Experience." *International Journal of Electronic Commerce*, vol. 18, no. 4, 2014, pp. 97–116.

Ha, Hong-Youl. "Factors Influencing Consumer Perceptions of Brand Trust Online." *Journal of Product & Brand Management*, vol. 13, no. 5, 2004, pp. 329–342.

Events

There is clear evidence that Manchester is proving themselves to be the leader in terms of the volume of events which mention the keywords 'eCommerce'. This is encouraging as events are vital for progress within a specific field; sharing ideas leads to progressive behaviour, it demonstrates the significant functioning ecosystem in Manchester.

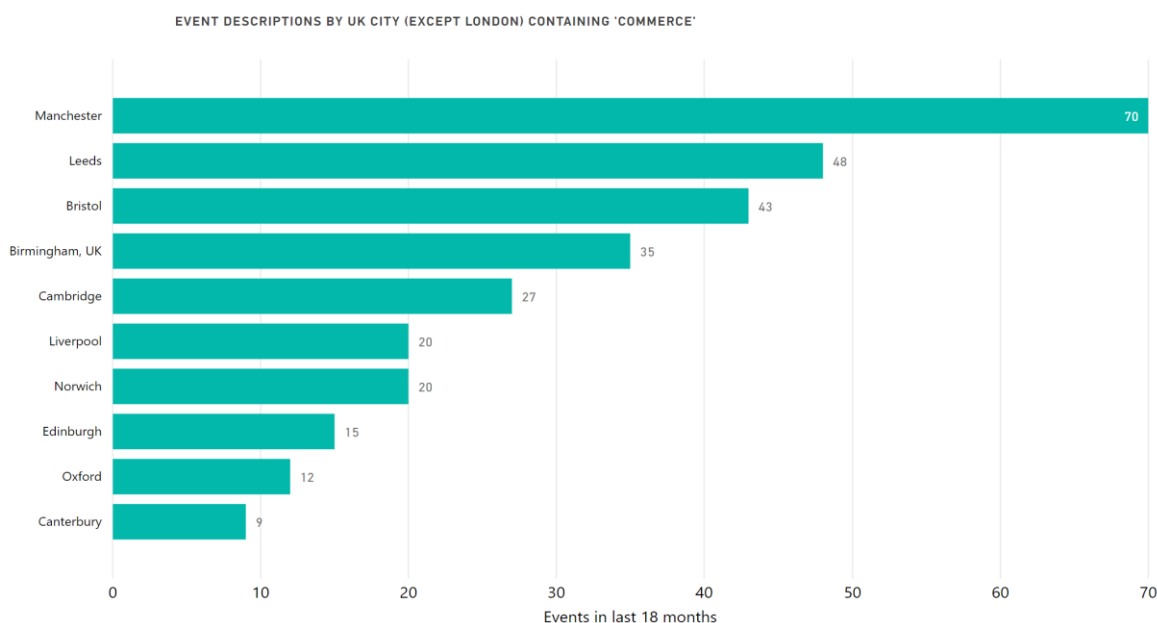
- **¹⁶Manchester has hosted 1221 events which relate to eCommerce since January 2019.** This is double the likes of Cambridge (651), Brighton (644) and Birmingham (620).
- **¹⁷Manchester hosts the most eCommerce events. It has hosted 70 different events which contain the keyword 'commerce',** 22 more than the next top ranked city Bristol (48).
- **¹⁸Manchester has hosted 408 Digital events and 146 Creative events. Manchester is ranked first in both categories.** There has been a significant increase in the number of events hosted in the last 18 months.

Keyword Data Visualisations

When we look closer at the eCommerce landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data assets using the following keywords that can be considered in their widest sense to be related to and impacted by events surrounding eCommerce.

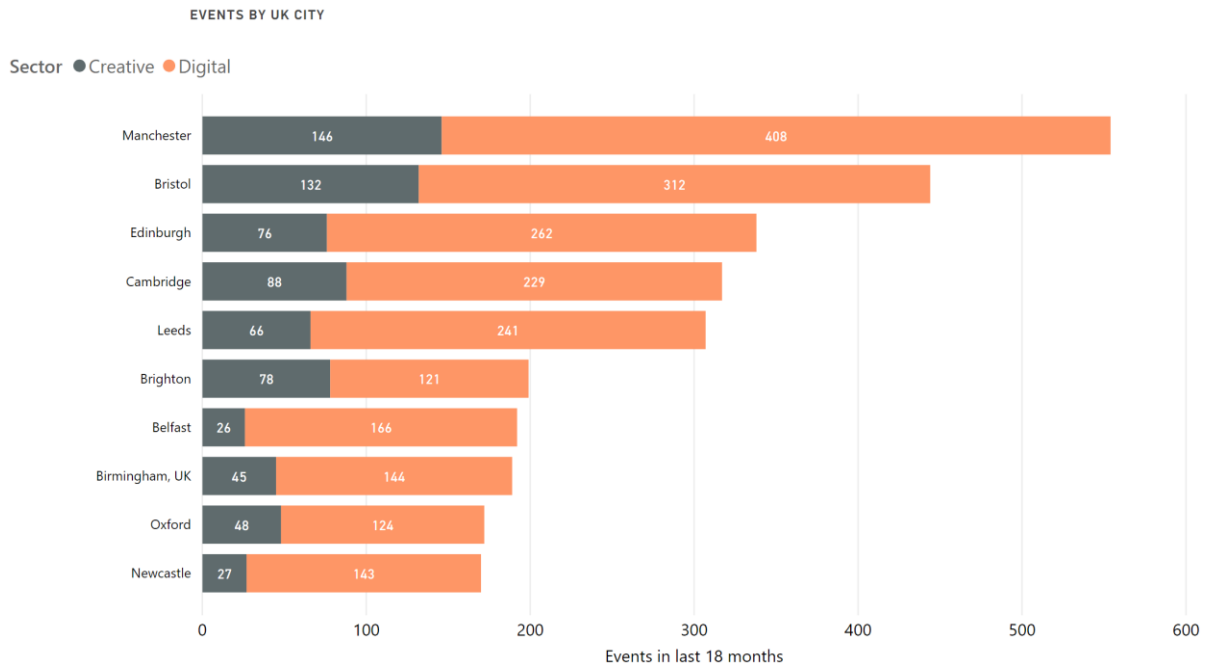
eCommerce is part of the wider digital disruption of retail and this is supported by the Digital & Creative sector ecosystem in Manchester. **In the past 18 months these two sectors both have more events than any other city in the UK outside of London.**



¹⁶ Using the [Data City's event explorer](#) which classifies events using cutting edge machine learning techniques.

¹⁷ Considering the keyword data visualisations provided by The Data City.

¹⁸ When we consider the wider scope of keywords relating to eCommerce - Creative and Digital.



Examples

The most notable event is [‘eCommerce Show North’](#) which will return in 2020 at *Manchester Central* at *Digital City Expo*. Other events include: [Insights 2020: eCommerce](#) and [How To Start & Grow An Ecommerce Business Even If You've Never Sold Anything](#) and [eCommerce lunch at The Ivy in Manchester](#), for an afternoon of insightful discussion on eCommerce growth, hosted by [Fluid Digital](#), [Klevu](#) and [LoyaltyLion](#) .

AI and Data Science

Introduction

Our work analysing 500 thousand technology events, 200 million scientific papers and patents, and 3.8 million web presences of UK registered companies has surfaced a significant strength of Greater Manchester — Artificial Intelligence & Data Science.

Why is AI and Data Science important to Manchester?

“Data science and artificial intelligence will change the world” - Turing Institute.

Artificial Intelligence and Data Science, powered by ever more available computing power are becoming ubiquitous technologies that can be applied in many contexts, across many sectors and are disrupting and changing the way research, development and business is executed.

Manchester has a critical place amongst computer science history including many firsts including the first stored program computer, the first floating point machine, the first transistor computer and the first computer to use virtual memory, which continues today. The research, events and organisational strengths and activity that we have evidenced confirms Manchester's demonstrable strengths across all parts of the technology, digital and data business landscape.

Organisations

In early 2019 The Data City reached a key milestone; successfully classifying, using machine learning and AI, over 1 million UK organisations into their relevant industries.

- **¹⁹In AI and Data Science, Manchester is among the most highly ranked Cities in the UK. Reading (403) has only 8 more organisations than Manchester (395) which have been classified within this sector.**
- **²⁰However, using keyword data Manchester is the highest ranked city in the UK. Around 1,500 organisations are located in Manchester, 500 more than the likes of Birmingham and Leeds.**
- **Of the AI and Data Science organisations in Manchester, 89.6% of records include the word 'Headquarters' and 75.3% of records include the word 'Automation'.**

Keyword Data Visualisations

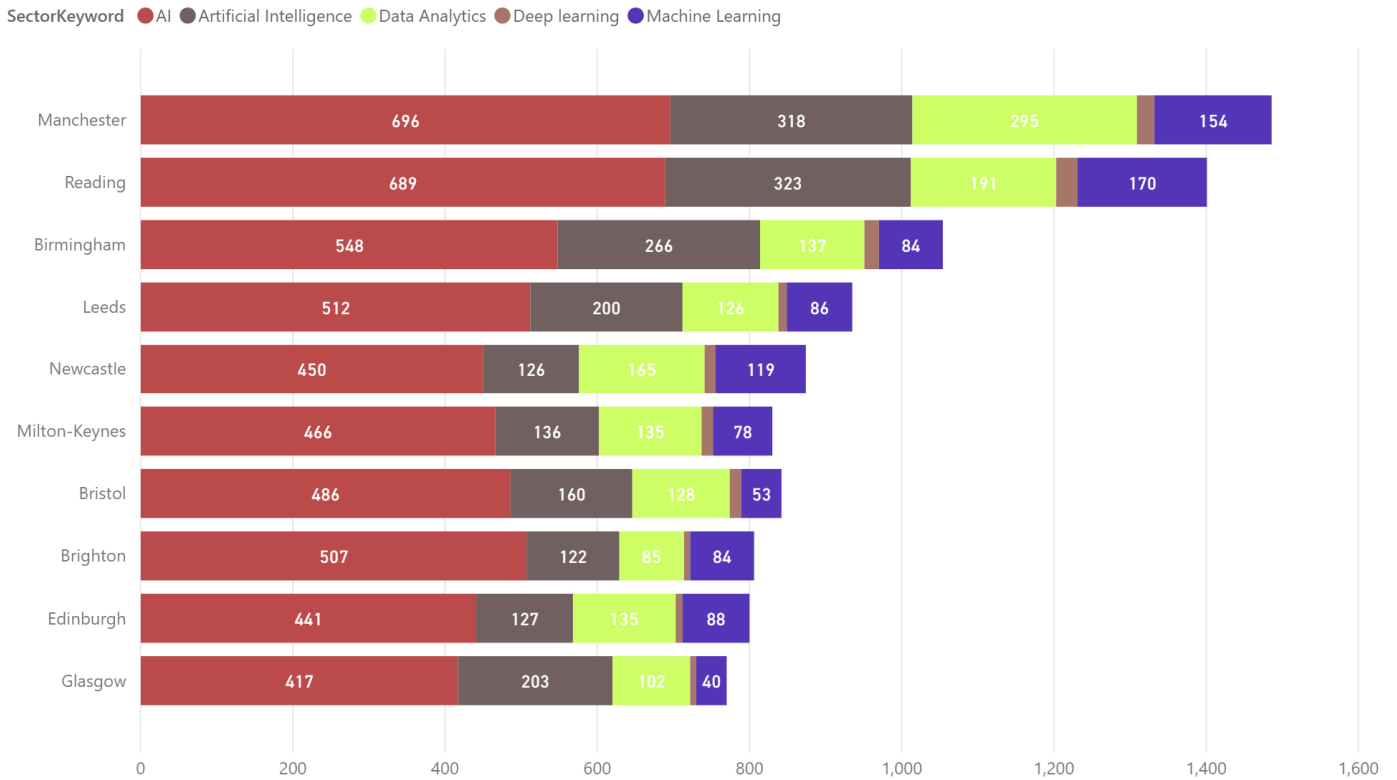
When we look closer at the AI and Data Science landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by organisations involved in AI and Data Science.

¹⁹ Using The Data City's tech census organisation explorer, [organisations which have been classified as AI and Data](#).

²⁰ Considering the keyword data visualisations and identifying keywords which relate to AI and Data: AI, Artificial Intelligence, Data Analytics, Deep Learning and Machine Learning.

COMPANIES WITH WEBSITES CONTAINING THE FOLLOWING KEYWORDS



Supporting Desk Based Research

Companies are using AI and Data to gain a critical advantage in the modern day. The success of AI within Manchester is evidential, companies like [Ditto.ai](#) focus on capturing human knowledge and recreating human expertise perfectly, they have produced a platform technology which is built on their patent-protected methodology. Another example includes [peak.ai](#) which harnesses the power of data to assist humans at work and improve business efficiency. Peak.ai are integrating their business into the heart of Manchester's tech industry by hosting events such as [Masters of AI](#). Other notable examples include [BJSS](#) which is the UK's leading privately-owned IT and Business Consultancy.

Research

The Data City's Data demonstrates that, outside of London, Manchester is delivering a substantial amount of research in artificial neural networks, data collection, data mining, data science, information systems and ontology; these all relate to AI and Data.

- From an academic and research perspective, ²¹**Manchester is publishing the highest volume of papers (over 5000)**, more than 1000 more than the second highest ranked city (Oxford).
- ²²**Manchester is the top city ranked by citations to papers and patents, recording over 200,000 citations to papers.** Over 73,000 citations are attributed to data mining, an important aspect of AI.
- The University of Manchester currently offers a BSc and MSc course in AI and Manchester Met offers [MSc Data Science](#) and [MSc Data Analytics](#).

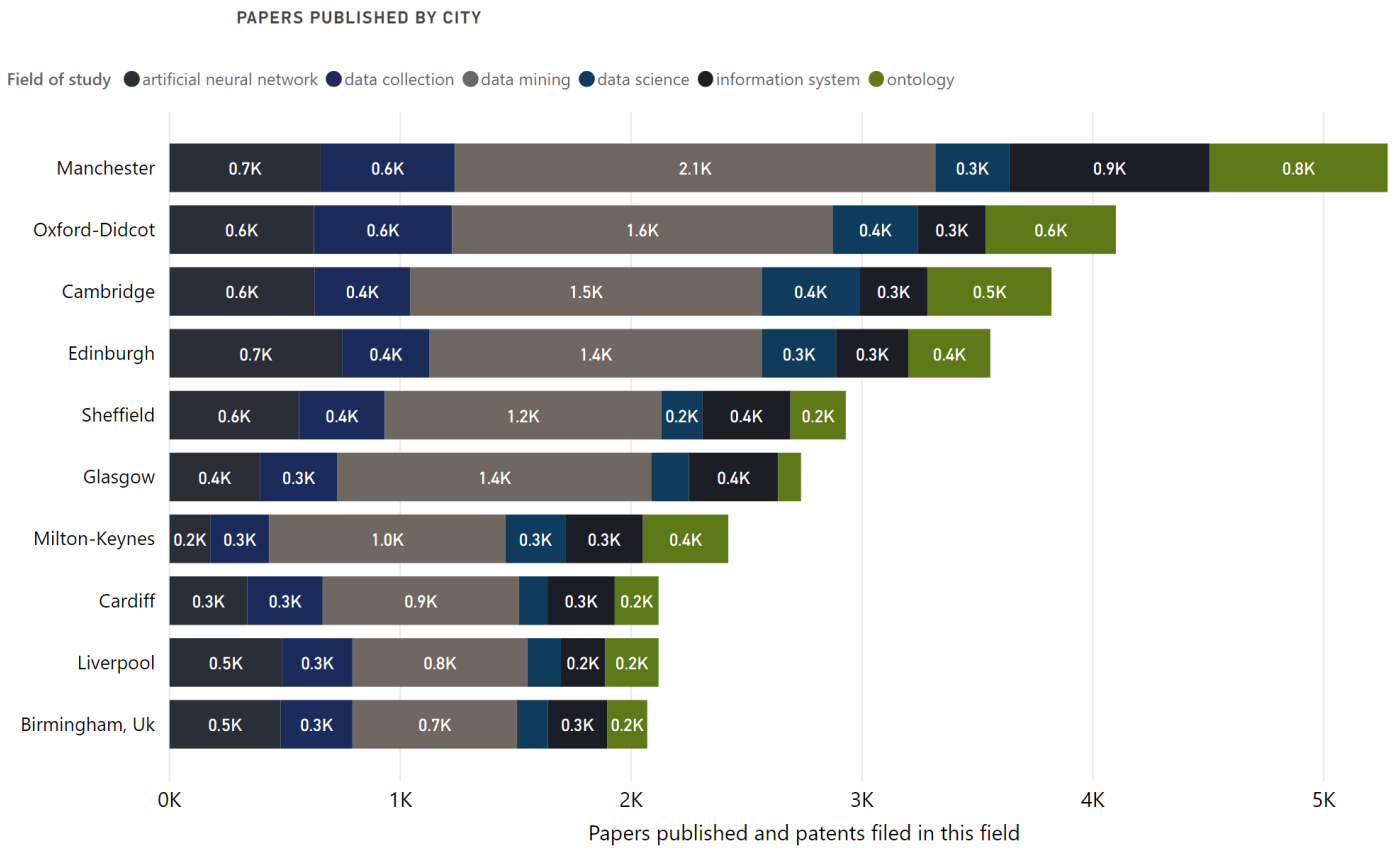
²¹ Outside of London.

²² Outside of London.

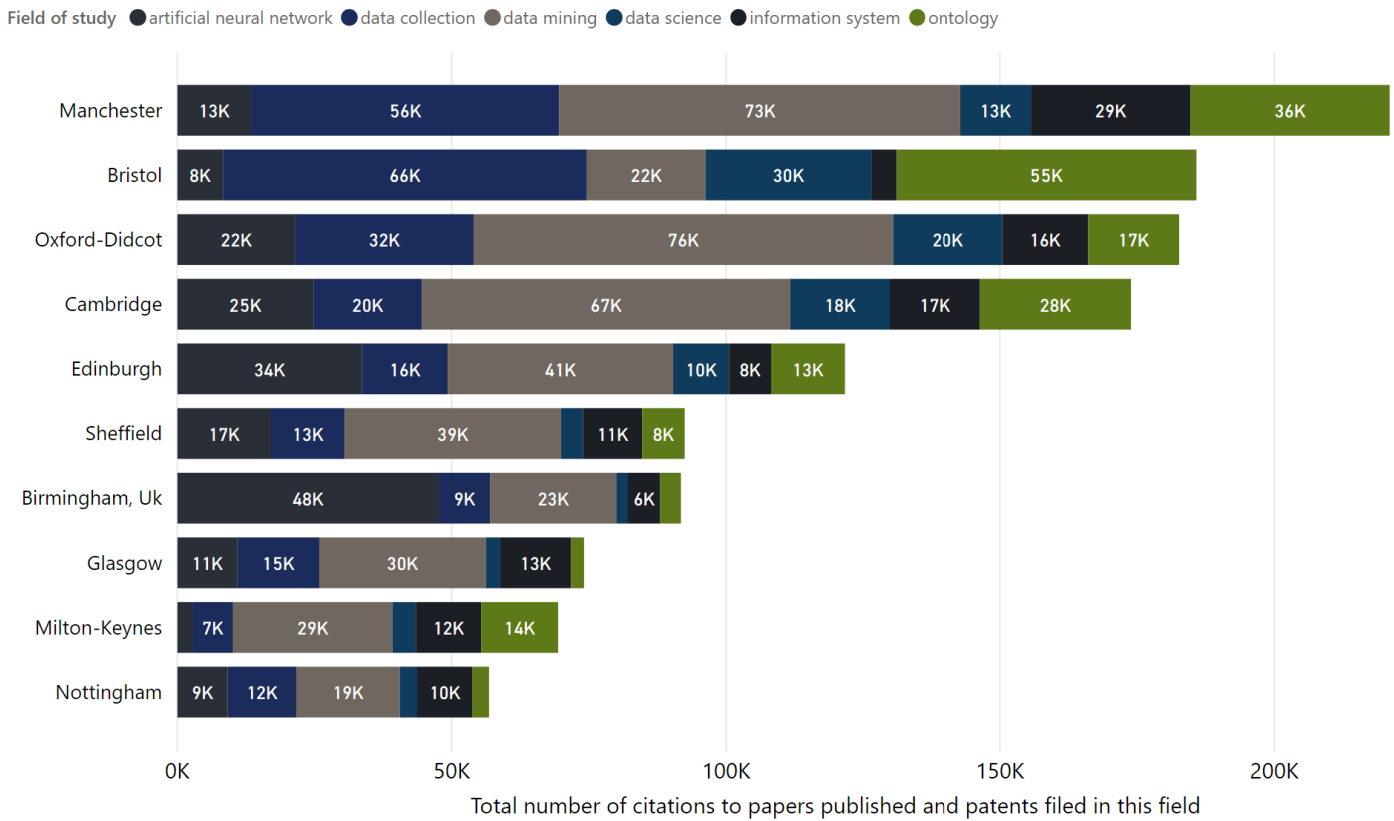
Keyword Data Visualisations

When we look closer at the AI and Data Science landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data assets using the following keywords that can be considered in their widest sense to be related to and impacted by research surrounding AI and Data Science.



CITATIONS TO PAPERS PUBLISHED BY INSTITUTIONS IN EACH CITY



Supporting Papers

Basit, Tehmina N. "Manual or Electronic? The Role of Coding in Qualitative Data Analysis." *Educational Research*, vol. 45, no. 2, 2003, pp. 143-154.

Brown, Gavin, et al. "Conditional Likelihood Maximisation: A Unifying Framework for Information Theoretic Feature Selection." *Journal of Machine Learning Research*, vol. 13, no. 1, 2012, pp. 27-66.

Furber, Steve B., et al. "The SpiNNaker Project." *Proceedings of the IEEE*, vol. 102, no. 5, 2014, pp. 652-665.

Events

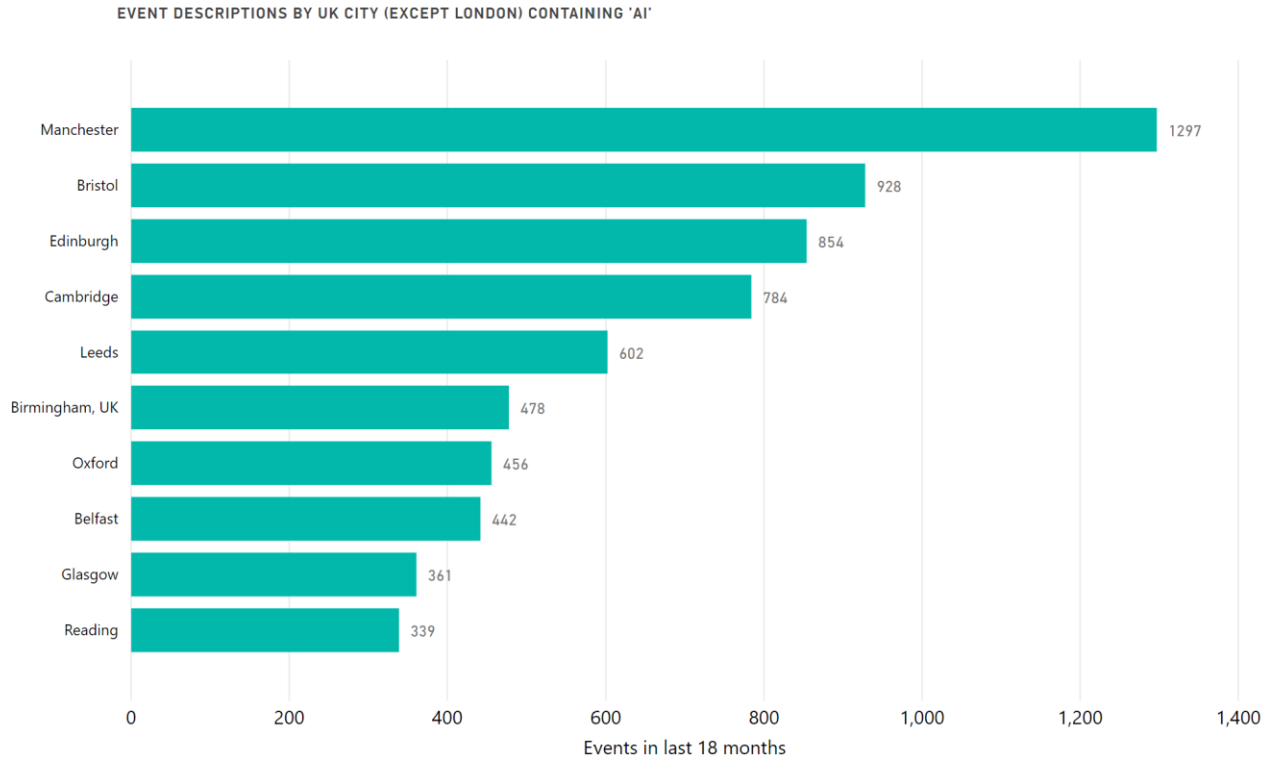
- ²³Manchester [hosts the highest volume of events in AI and Data Science \(145\)](#). In comparison to other cities, Manchester has hosted 30 more than the second highest rank city Edinburgh (113) and almost three times as many as the likes of Oxford (56) or Leeds (53). These events have been collected from *Eventbrite* and *Meetup* since January 2018.
- **When looking at event descriptions by UK city which contain the keywords 'Artificial Intelligence' or 'AI', Manchester has hosted 1297 different events making it the top ranked city.**

²³ Using The Data City's events explorer, comparing AI and Data events to other cities in the UK, outside of London.

Keyword Data Visualisations

When we look closer at the AI and Data Science landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by events surrounding AI and Data Science.



Examples

In November, the University of Manchester will host the [20th International Conference on Intelligent Data Engineering and Automated Learning \(IDEAL\)](#) and Manchester Metropolitan University will host [Human-Based Analytics and AI for Business and Social Science](#) (hosted partly by the Royal Statistical Society, and is part of the ESRC Festival of Social Science 2019).

Cyber (Security)

Introduction

Our work analysing 500 thousand technology events, 200 million scientific papers and patents, and 3.8 million web presences of UK registered companies has surfaced a significant strength of Greater Manchester — Cyber Security.

Why is Cyber Security important to Manchester?

Cyber security is part of the underpinning infrastructure of the digital transformations that all parts of the economy and organisations both public and private are undergoing. It is an ever changing and developing sector requiring skills and expertise that crosscut with all aspects of data, digital and technology.

Our data shows that as well as being integral to the UK's emerging technologies sector and leading in many parts Manchester also has significant strength in Cyber Security.

Organisations

In early 2019 The Data City reached a key milestone; successfully classifying, using machine learning and AI, over 1 million UK organisations into their relevant industries.

- **²⁴Currently Manchester sits in a close second (747 organisations) to Reading (830) in the number of organisations classified as Cyber.**
- **²⁵Manchester is currently the top city ranked by the number of organisations which contain websites containing keywords related to Cyber.**
- **Of the 486 companies with websites containing the keyword Cyber Security, 73.1% contain the keyword 'Worldwide' and 51.8% of records contain the keyword 'Idea'.** This represents the scale at which Manchester operates on and highlights Manchester's innovative economy.

Keyword Data Visualisations

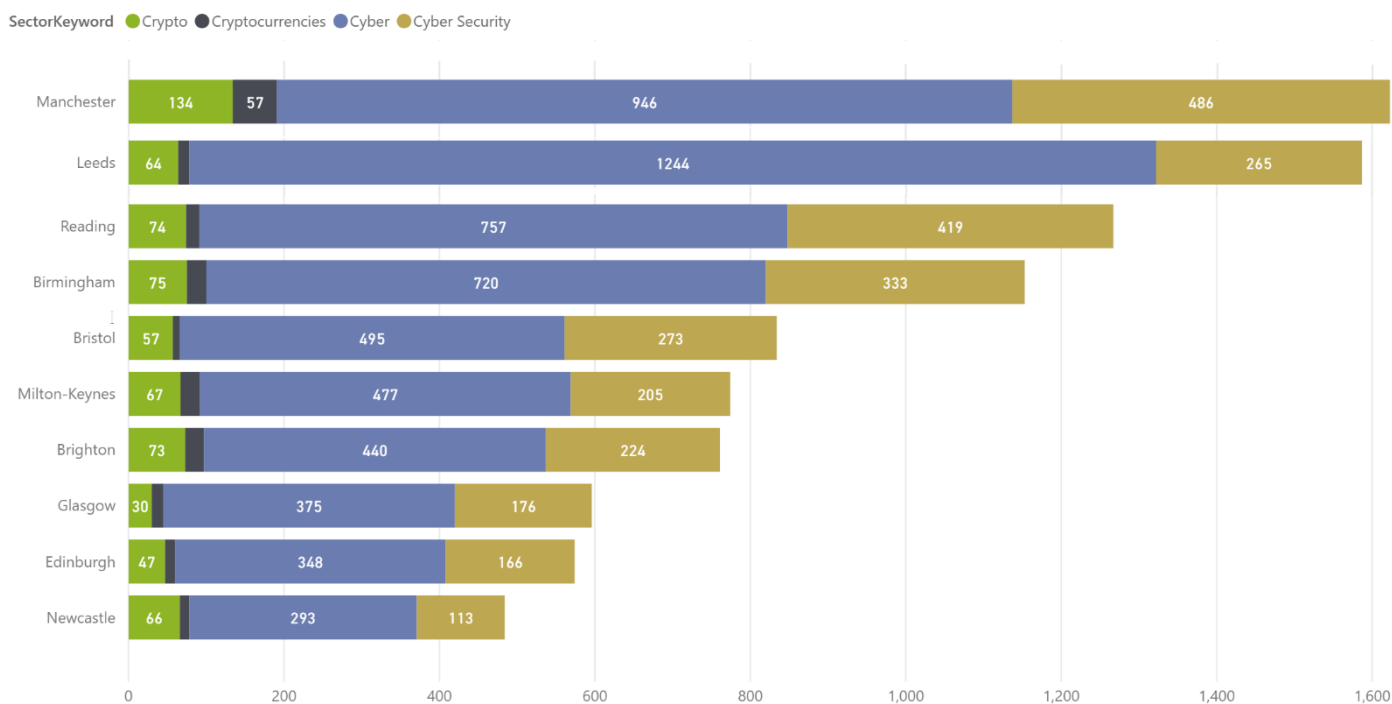
When we look closer at the Cyber (Security) landscape we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by organisations involved in Cyber (Security).

²⁴ Using The Data City's tech census organisation explorer, [organisations which have been classified as Cyber](#).

²⁵ When considering The Data City's keyword data asset, using the keywords: Cyber, Cyber Security, Cryptocurrencies and Crypto.

COMPANIES WITH WEBSITES CONTAINING THE FOLLOWING KEYWORDS



Supporting Desk Based Research

Due to the rise in data security and national scares such as the [NHS digital hack](#) in 2017, there has been an emergence of Cyber security companies. Examples in Manchester includes the likes of [4Secure](#), an organisation who are experts on advising, preventing and solving data security problems. Their products include the only standalone hardware-based tool for erasure of hard disks. 4Secure have released statistics such as there is a 48% increase in banking fraud each year, this highlights the importance of organisations to improve cyber security. Similar businesses include [WeGoBeyond](#) which design applications for the cloud where user security only allows access to those permitted to the data. Their algorithm is highly optimised for scalability. They offer training and have worked with the likes of Leicestershire County Council and North Yorkshire County Council. Other notable examples include [cafsolutions](#) which works with the market leaders in the Public Sector to give an independent view of the options available in business rates software and training solutions.

As well as home-grown companies including Avecto, Hedgehog, NCC Group, and Secarma, Manchester's strength in cyber has also attracted a number of established businesses to expand into Manchester, including global giants Northrop Grumman and Raytheon. More recently, UK's Government Communications HQ (GCHQ) has announced it is establishing a new centre in Manchester in late 2019.

Research

The Data City's Data demonstrates that, outside of London, Manchester is delivering a substantial amount of research in cloud computing, information technology and server. All of these relate to Cyber (Security).

- ²⁶**Manchester is ranked joint first in the [UK ranking for cloud computing \(papers\)](#), a key aspect of Cyber technology.**
- ²⁷**Manchester is ranked first in the number of papers published by city related to Cyber (Security).**
- ²⁸**Manchester is ranked second only to Cambridge in the number of citations to papers published and patents filed in Cyber.**

Four universities have set up the Greater Manchester Cyber Foundry, a program open to all SMEs in Greater Manchester, which explores the ways cyber security, can boost businesses. The program incorporates the knowledge and expertise of four universities all of which work in partnership to deliver a course striving to improve cyber operations. This is a £6million cyber security scheme that will help to protect Greater Manchester's small and medium-sized companies against malicious computer attacks.

Keyword Data Visualisations

When we look closer at the Cyber (Security) landscape we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by research surrounding Cyber (Security).

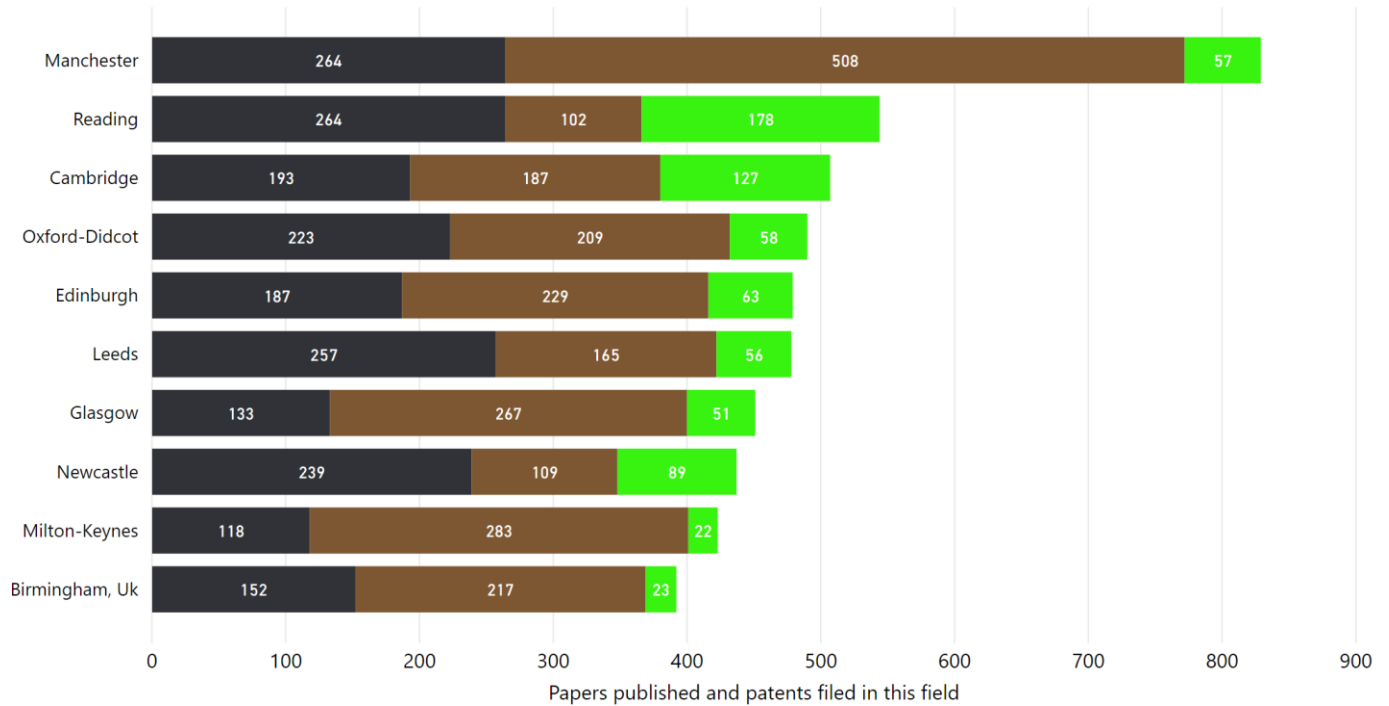
²⁶ When using The Data City's innovation explorer, outside of London.

²⁷ By exploring the data further and identifying Manchester's strengths in The Data City's keyword data visualisation. The keywords used in this instance are cloud computing, information technology and server.

²⁸ When exploring The Data City's keyword data visualisation.

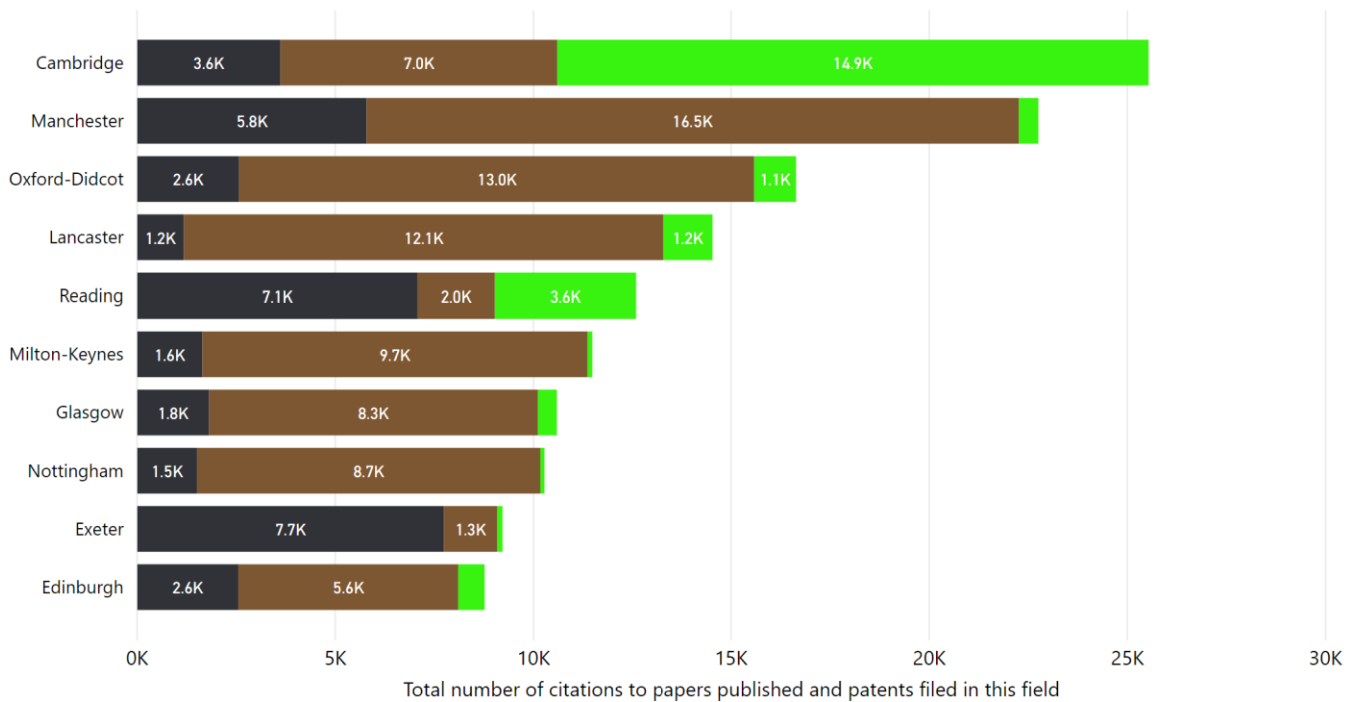
PAPERS PUBLISHED BY CITY

Field of study ● cloud computing ● information technology ● server



CITATIONS TO PAPERS PUBLISHED BY INSTITUTIONS IN EACH CITY

Field of study ● cloud computing ● information technology ● server



Examples

Milosevic, Nikola, et al. "Machine Learning Aided Android Malware Classification." *Computers & Electrical Engineering*, vol. 61, 2017, pp. 266–274.

Akarca, D., et al. "Blockchain Secured Electronic Health Records: Patient Rights, Privacy and Cybersecurity." 2019 10th International Conference on Dependable Systems, Services and Technologies (DESSERT), 2019, pp. 108–111.

Han, Runchao, et al. "Evaluating CryptoNote-Style Blockchains." International Conference on Information Security and Cryptology 2018, 2018, pp. 29-48.

Events

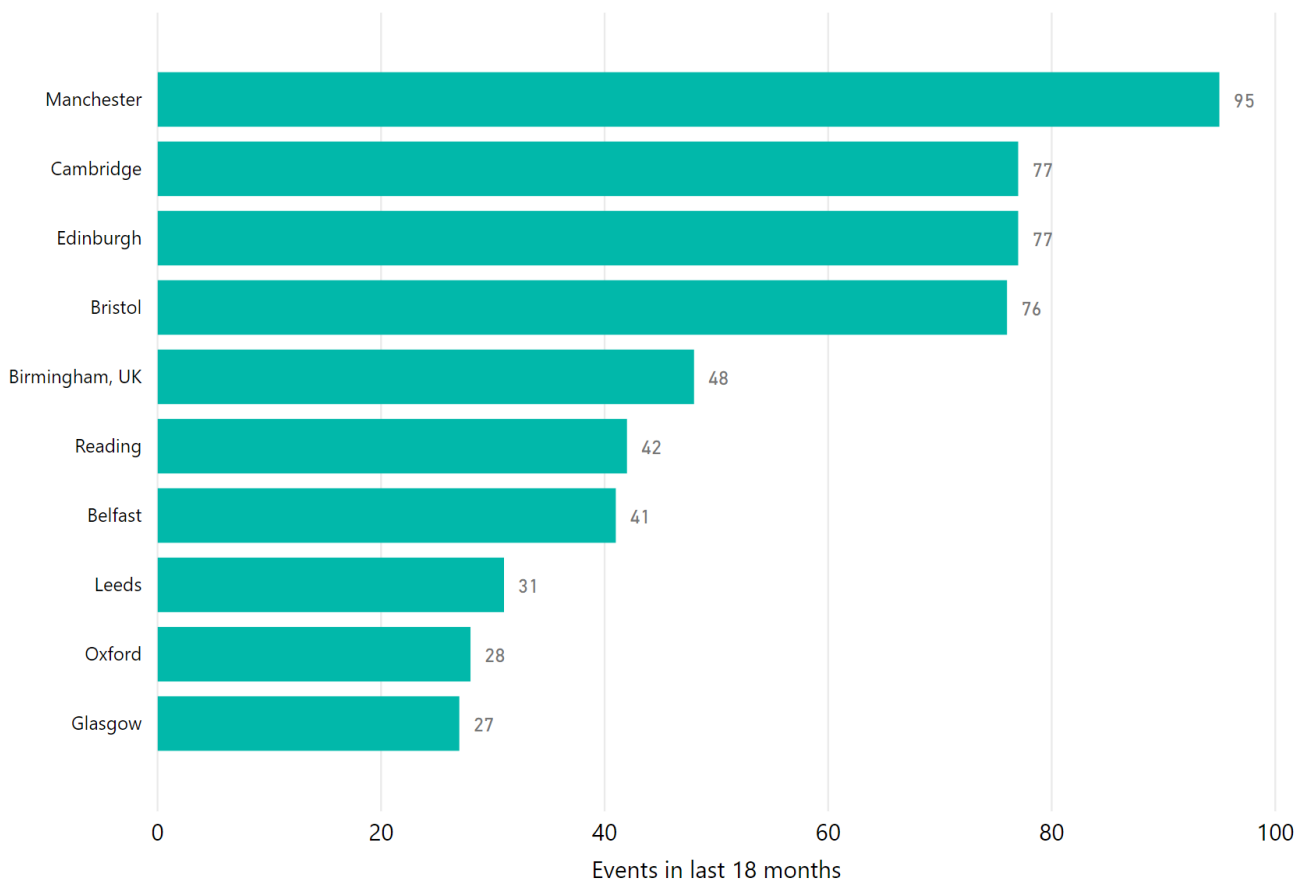
- ²⁹**Manchester hosts the highest volume of events in Cyber (29).** In comparison to other cities, Manchester has hosted double the likes of Glasgow (14) and Birmingham (14). These events have been collected from *Eventbrite* and *Meetup* since January 2018.
- ³⁰**Manchester is ranked first using the keyword 'Cyber' where it hosted 95 events over the last 18 months.** This is 18 more than joint second place Cambridge (77) and Edinburgh (77).

Keyword Data Visualisations

When we look closer at the Cyber (Security) landscape we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by events surrounding Cyber (Security).

EVENT DESCRIPTIONS BY UK CITY (EXCEPT LONDON) CONTAINING 'CYBER'



Examples

The GM Cyber Foundry has also hosted the [GM Cyber Foundry: Defend, Innovate, Grow](#) event which helped SME's learn from Industry, Government and Academic thought leaders in a series of interactive

²⁹ Using The Data City's events explorer, comparing Cyber events to other cities in the UK.

³⁰ Using The Data City's keyword data visualisation which have explored keywords within event descriptions which contain the word 'Cyber'.

workshops designed to boost the Cyber innovation and resilience of the Greater Manchester business community. The programme is free to all SMEs regardless of sector in the Greater Manchester Postcode area.

Other Examples include [Preventing Cloud Cyber Security Breaches](#) hosted by ECSC Group PLC which has almost two decades experience in the prevention of cyber security breaches and incident response. Perhaps a crucial part of Cyber security is understanding [how to buy cyber security services](#), which Manchester can offer. These events link to the high quality of cyber security services available in Manchester.

Construction Tech

Introduction

Our work analysing 500 thousand technology events, 200 million scientific papers and patents, and 3.8 million web presences of UK registered companies has surfaced a significant strength of Greater Manchester — Construction Tech.

Why is Construction Tech important to Manchester?

Over the past decade [more tall buildings have been built in Manchester than any other UK city outside of London](#). This strength has been supported by UK-leading research strengths in engineering management and structural engineering with courses like The University of Salford's MSc in construction management offered to graduates.

But the biggest strengths in Manchester are from the companies that have designed and built new award-winning neighbourhoods such as Ancoats, named among the [50 coolest neighbourhoods in the world by Time Out magazine](#), such as Urban Splash. The companies have built tall buildings in the city using lean construction and more environmentally sustainable methods.

Organisations

In early 2019 The Data City reached a key milestone; successfully classifying, using machine learning and AI, over 1 million UK organisations into their relevant industries.

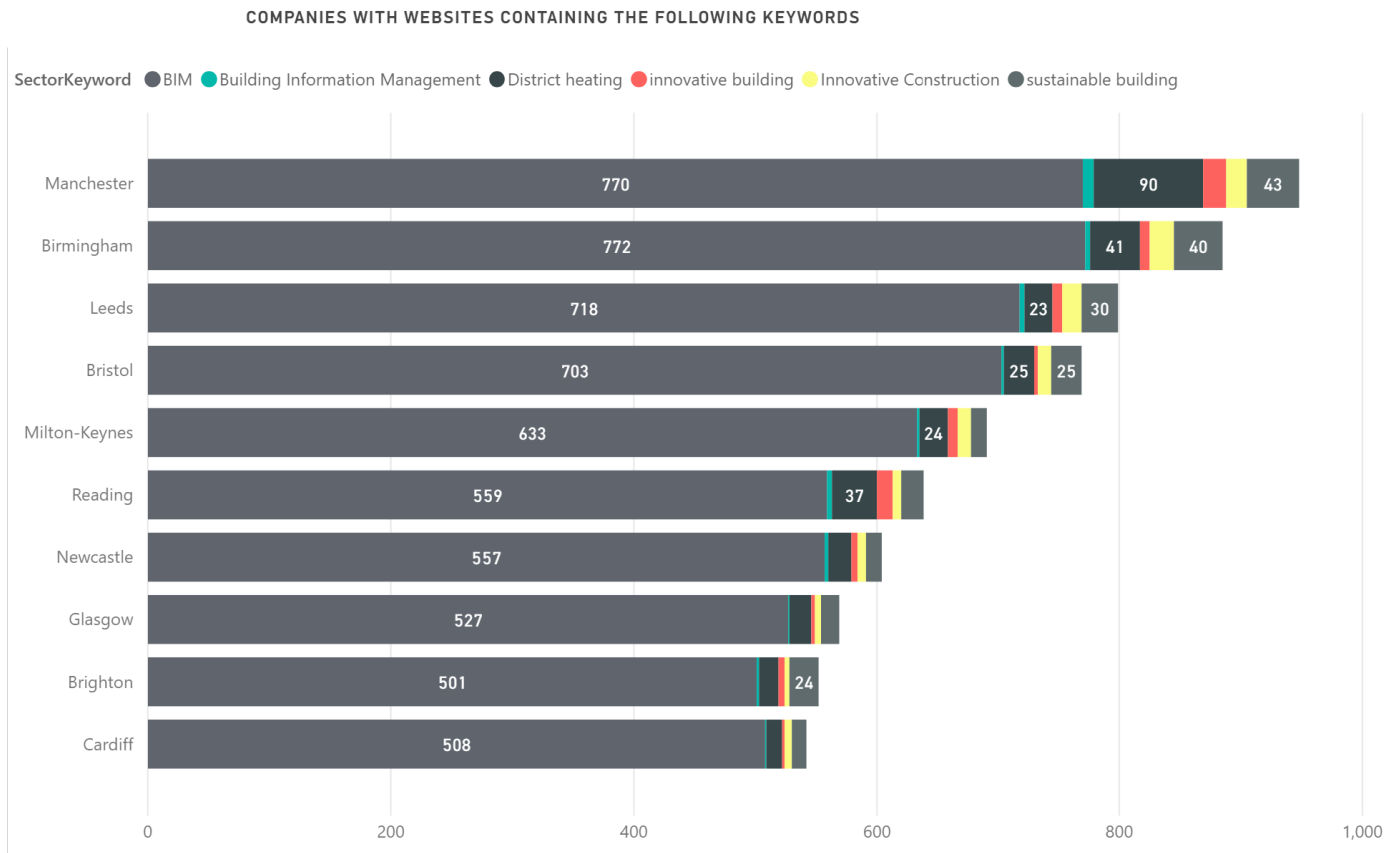
- ³¹**Manchester ranks first in the number of organisations websites which contain keywords related to construction tech.** Manchester has almost 1000 organisations linked to construction tech which is substantial compared to other large cities in the UK such as Leeds (800) and Bristol (770).
- Exploring this data further shows, **of the construction tech business in Manchester 63.4% include the keyword 'research', 52.6% include the keyword 'innovation' and 51.1% include the keyword 'recruitment'**. This highlights the growth within the construction tech sector.

³¹ Outside of London, using keywords: BIM, Building Information Management, District Heating, Innovative Building, Innovative Construction and Sustainable Building

Keyword Data Visualisations

When we look closer at the Construction Tech landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by organisations involved in Construction Tech.



Supporting Desk Based Research

Greater Manchester's companies are the driving force of its construction tech strengths. Wolfson Economics Prize winning [Urbed Coop](#) are world-leading consultants in town planning. Companies from just outside of Greater Manchester like [Vital Energi](#) who are providing the city's municipal buildings with low-carbon power, heat and hot water through district heating, helping the region meet its stated ambition to be carbon neutral by 2038. Salford-based [Leep Utilities](#) own and operate electricity, water, and heating networks at large sites in the UK's leading cities. Eccles-based [Oakwood Engineering Solutions Ltd](#) are global leaders in 3D modelling for building and BIM.

Research

³²**Researchers at the Universities in Greater Manchester publish more papers on structural engineering, engineering management, and sustainable development than anywhere else in the country.** In these fields there is a particular strength at The University of Salford, with collaborations all around the world but also within the region with The University of Bolton, The University of Liverpool, Manchester's Universities, and The University of Huddersfield, form a strong local cluster of excellence centred on Salford.

The Data City's Data demonstrates that, outside of London, Manchester is delivering a substantial amount of research in engineering management, structural engineering and sustainable development. All of these relate to Construction Tech.

- ³³**Manchester is ranked first in the quantity of papers related to Construction Tech** where it has produced over 2000 papers in the fields mentioned. This is significantly more than any other city in the UK.
- ³⁴**Manchester is ranked third behind Oxford and Cambridge in the number of papers and patents filed in Construction Tech** where it has been cited over 35,000 times.
- **A particularly notable researcher is Professor Yusuf Arayici at The University of Salford, one of the world's most-cited researchers in the field of Building Information Modelling (BIM).** The University of Salford and former Professor (now at Huddersfield) Lauri Koskela is also one of the most important places for the research field of lean construction, a requirement in a world city like Manchester with comparatively low rents that builds so many tall buildings.

Keyword Data Visualisations

When we look closer at the Construction Tech landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by research surrounding Construction Tech.

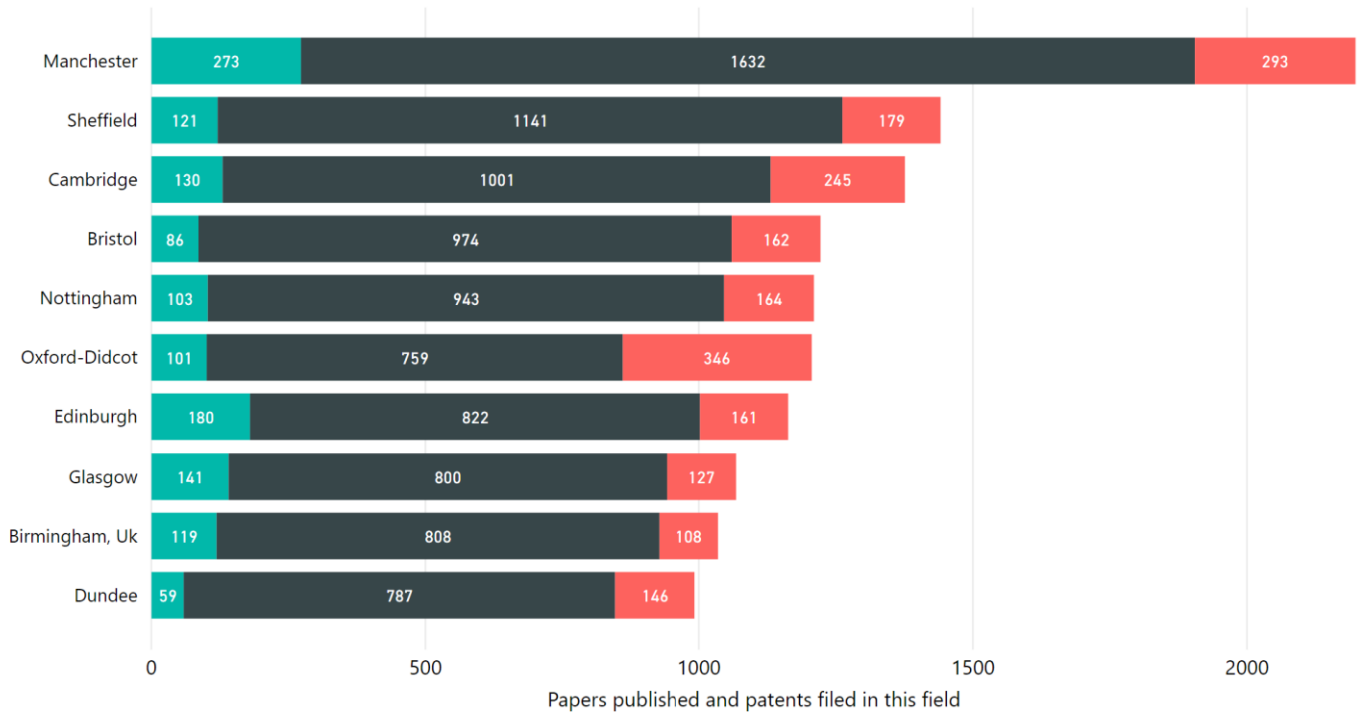
³² Outside of London.

³³ Using The Data City's keyword data visualisation which analyses the quantity of papers published by city.

³⁴ When exploring The Data City's keyword data visualisation.

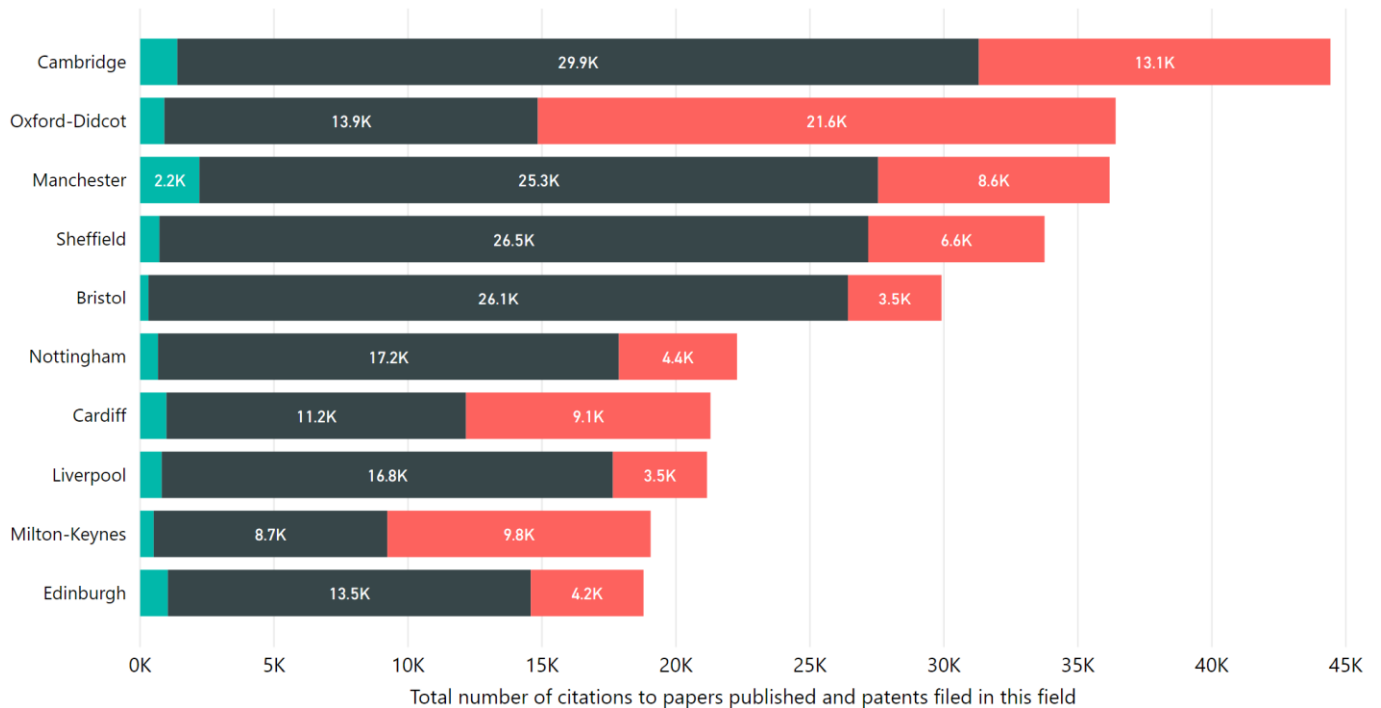
PAPERS PUBLISHED BY CITY

Field of study ● engineering management ● structural engineering ● sustainable development



CITATIONS TO PAPERS PUBLISHED BY INSTITUTIONS IN EACH CITY

Field of study ● engineering management ● structural engineering ● sustainable development



Examples

Recent notable publications include:

- Khosrowshahi, F., & Arayici, Y. (2012). Roadmap for implementation of BIM in the UK construction industry. *Engineering, Construction and Architectural Management*, 19(6), 610–635.

- Sacks, R., Koskela, L., Dave, B. A., & Owen, R. L. (2010). Interaction of lean and building information modeling in construction. *Journal of Construction Engineering and Management-Asce*, 136(9), 968–980.
- Abuelmaatti, A., & Ahmed, V. (2018). Collaboration environments for small and medium-sized architecture, engineering and construction enterprises: success factors in implementation. *International Journal of Information Technology and Management*, 17(4), 313–333.
- Ahuja, R., Sawhney, A., & Arif, M. (2017). Driving lean and green project outcomes using BIM: a qualitative comparative analysis. *International Journal of Sustainable Built Environment*, 6(1), 69–80.

Events

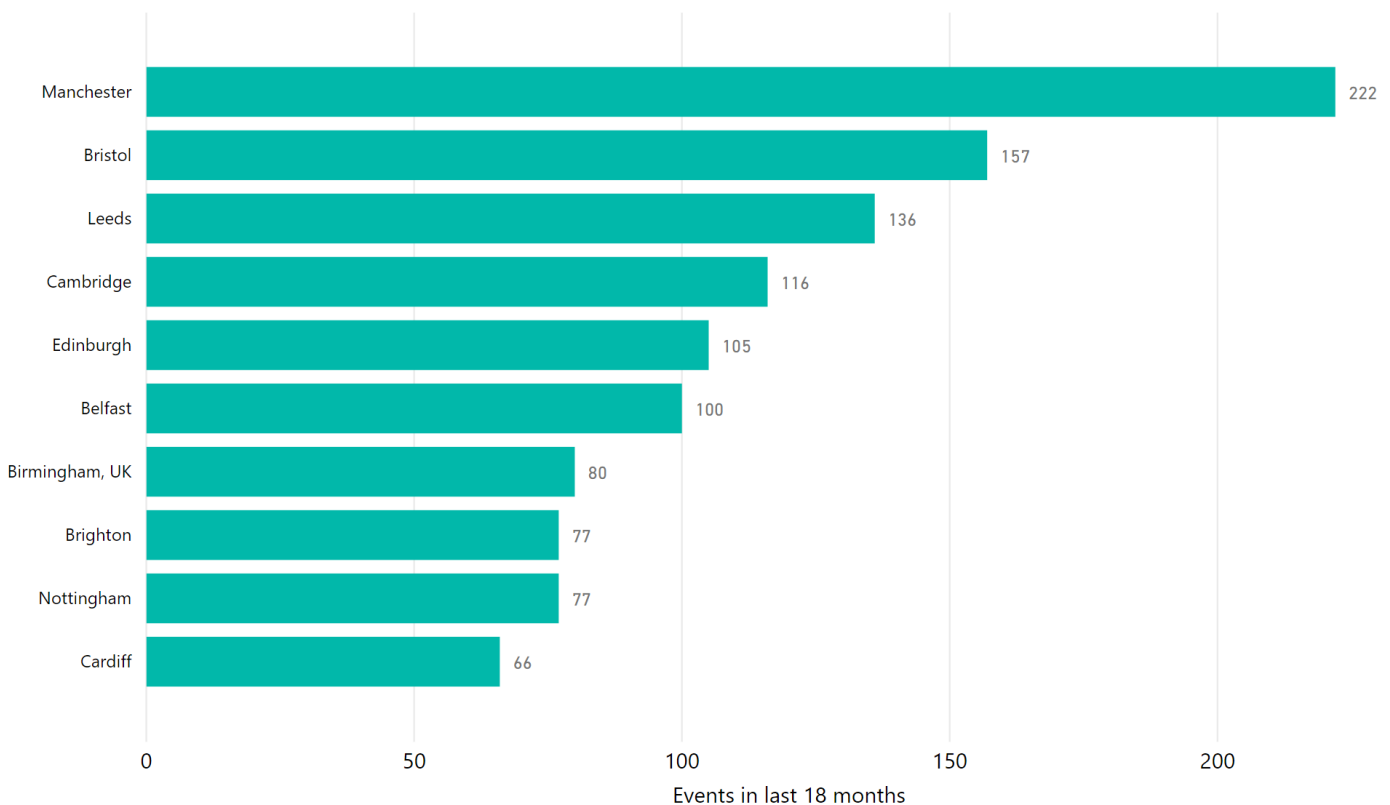
- ³⁵ **Manchester hosts the fifth highest volume of events (7) in Construction Tech.** In comparison to other cities, Birmingham hosts the most (12), Edinburgh hosted 10 and Newcastle, 8. These events have been collected from *Eventbrite* and *Meetup* since January 2018.
- ³⁶ **When searching for events descriptions which contain the keywords 'building' and 'tech', Manchester is the top ranked city (222 event descriptions).** In comparison, Birmingham is ranked seventh (80 event descriptions).

Keyword Data Visualisations

When we look closer at the Construction Tech landscape, we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by events surrounding Construction Tech.

EVENT DESCRIPTIONS BY CITY (EXCEPT LONDON) CONTAINING 'BUILDING' AND 'TECH'



Examples

An area of weakness for Greater Manchester's construction tech ambitions is events, although it should be noted that, probably due to the engineering origins of the field rather than computer science, public

³⁵ Using The Data City's events explorer, comparing construction events to other cities in the UK, outside of London.

³⁶ Using The Data City's keyword data visualisations.

events are not as common for spreading technical excellence in construction tech. Still, in building information management (BIM) and construction more generally there are fewer events advertised to the public than a strong competitor city such as Birmingham.

This may be an artefact of our data collection process, nationally important annual conferences such as [The BIM Conference Salford](#) are not advertised on standard events aggregators. But it may also be a sign that the city's strong companies have an excellent chance to lead in this field and work together more closely.

Internet of Things

Introduction

Our work analysing 500 thousand technology events, 200 million scientific papers and patents, and 3.8 million web presences of UK registered companies has surfaced a significant strength of Greater Manchester — Internet of Things.

Why is Internet of Things important to Manchester?

The rapid growth of internet enabled, sensors, actuators and control services - The Internet of Things (IoT), is transforming the way we interact with our homes, the built environment and infrastructure. Manchester has specific and general strengths, assets and capabilities across the Internet of Things sector as demonstrated by our data.

Data Science, AI, Cyber Security, Service Design, MedTech and Construction Technology all crosscut significantly with IoT, the strengths of Manchester in these sectors married with specific project examples such as [City Verve](#) make Manchester a centre for IoT in The UK.

Organisations

In early 2019 The Data City reached a key milestone; successfully classifying, using machine learning and AI, over 1 million UK organisations into their relevant industries.

- ³⁷**Currently Manchester sits in a close second (58 organisations) to Reading (83) in the number of organisations which have been classified as IoT.**
- ³⁸**Manchester is currently ranked second to Reading with the number of organisations which contain websites containing keywords related to IoT.** Manchester has over 1,100 organisations compared to Reading which has around 1,300.
- **Of the 183 organisations with websites containing the keyword 'Internet of Things' in Manchester, 69.4% of records include the keyword 'recruitment' and 50.7% include the keyword 'collaboration'.** This highlights Manchester's scale of economy is growing fast and shows organisations are working together.

Keyword Data Visualisations

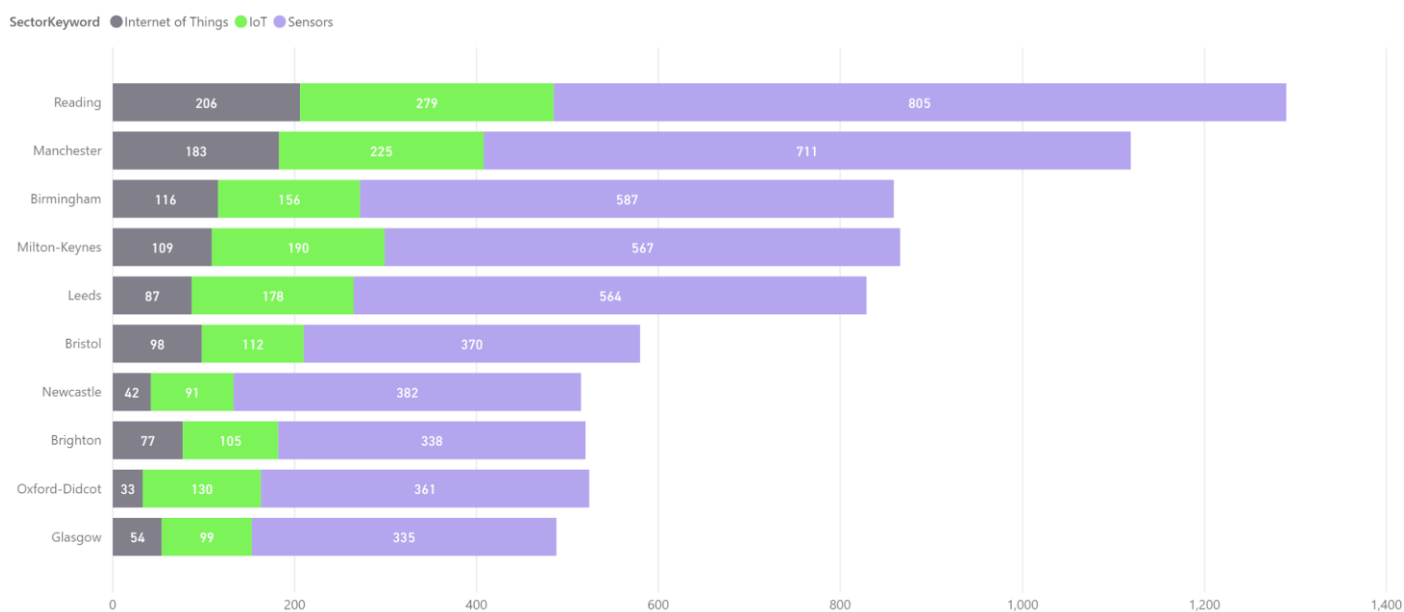
When we look closer at the IoT landscape we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by organisations involved in IoT.

³⁷ Using The Data City's tech census organisation explorer, [organisations which have been classified as IoT](#).

³⁸ When considering The Data City's keyword data asset using keywords: Internet of Things, IoT and Sensors.

COMPANIES WITH WEBSITES CONTAINING THE FOLLOWING KEYWORDS



Supporting Desk Based Research

There is a wealth of organisations that are working within the IoT space within Manchester. The most notable example is [ARM](#), the world’s leading semiconductor IP company, has over 250 people working in software engineering on IoT technologies. ARM want to use Manchester as a location from which to grow their business and aim to have a 1,000 people in Manchester in the next few years. [RepublicofThings](#) collaborates with practitioners and policy makers across organisations ambitious for technology-led transformation, including national and local government, councils, the NHS and the community sector. In contrast to [RepublicofThings](#), supporting the public sector, [CloudEnergySoftware](#) offers a range of integrated applications and SaaS Solutions that have been developed to solve the most challenging data capture, analytics and reporting difficulties in the IoT, Energy and Utilities markets. Other notable examples include [digiryte](#) (a tech consultancy), [flexgrid](#) (a cloud service provider) and [mobica](#) (a global software services company).

Research

Although Manchester is competing with Reading in the number of organisations within the IoT space, it is somewhat lacking in the number of papers and patents filed in this field. This could be due to difficulty in identifying papers which reference internet of things as the subject area is mainly related to practical applications.

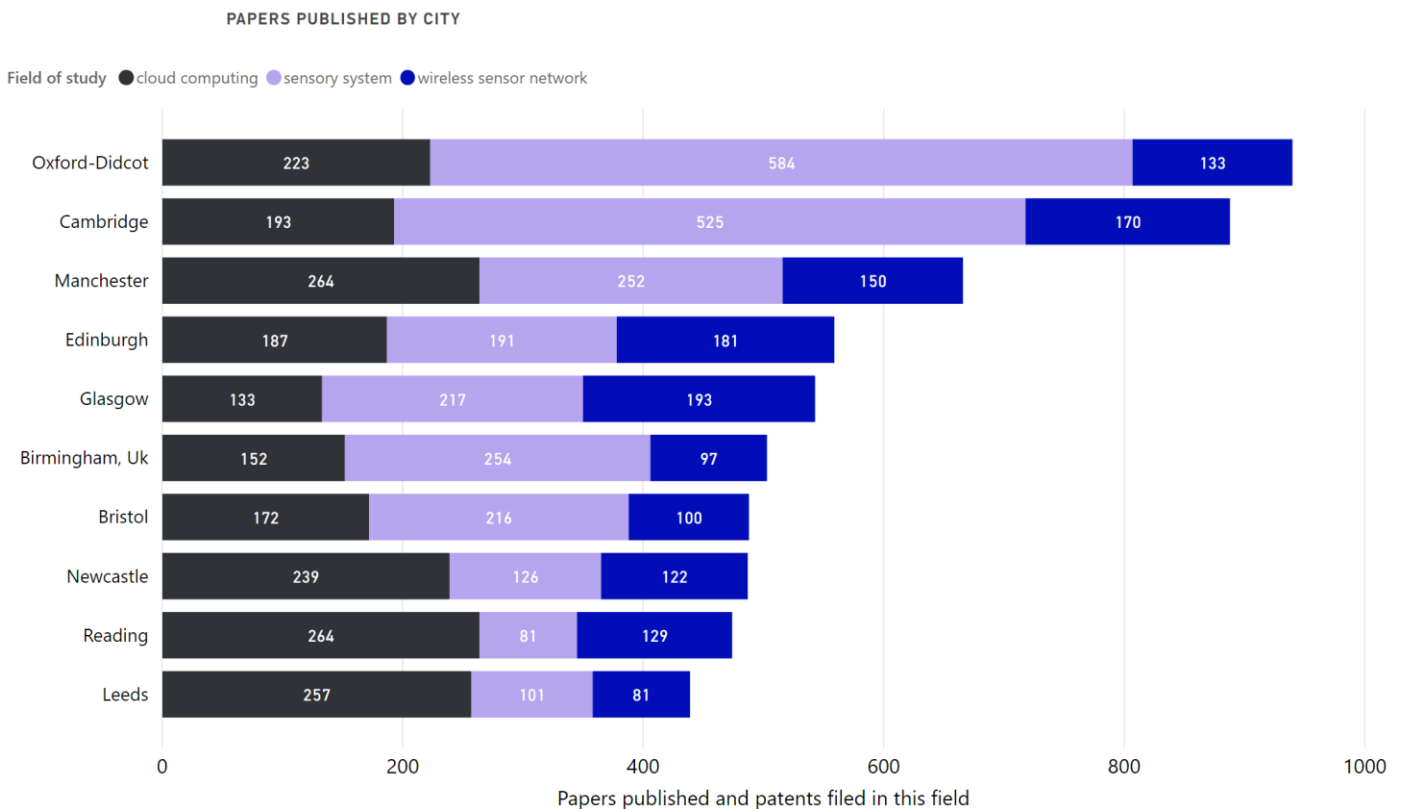
The Data City's Data demonstrates that, outside of London, Manchester is delivering a substantial amount of research in cloud computing, sensory system and wireless sensor network. All of these relate to IoT.

- ³⁹**When analysing the quantity of papers published by city, Manchester is ranked fifth in IoT**, where it has produced over 250 papers in sensory systems, a key aspect of IoT.
- ⁴⁰**When analysing keywords, Manchester is ranked third by city which has papers published in the categories previously specified.** Manchester has had over 600 papers and patents filed in these fields.

Keyword Data Visualisations

When we look closer at the IoT landscape we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data assets using the following keywords that can be considered in their widest sense to be related to and impacted by research surrounding IoT.



³⁹ Using The Data City's keyword data visualisations.

⁴⁰ Using The Data City's keyword data visualisations supplied.

Examples

Vaughan, John, et al. "Floor Sensors of Animal Weight and Gait for Precision Livestock Farming." 2017 IEEE SENSORS, 2017, pp. 1-3.

Krachunov, Sammy, et al. "Energy Efficient Heart Rate Sensing Using a Painted Electrode ECG Wearable." 2017 Global Internet of Things Summit (GloTS), 2017, pp. 1-6.

Good, Nicholas, et al. "Review and Classification of Barriers and Enablers of Demand Response in the Smart Grid." Renewable & Sustainable Energy Reviews, vol. 72, 2017, pp. 57-72.

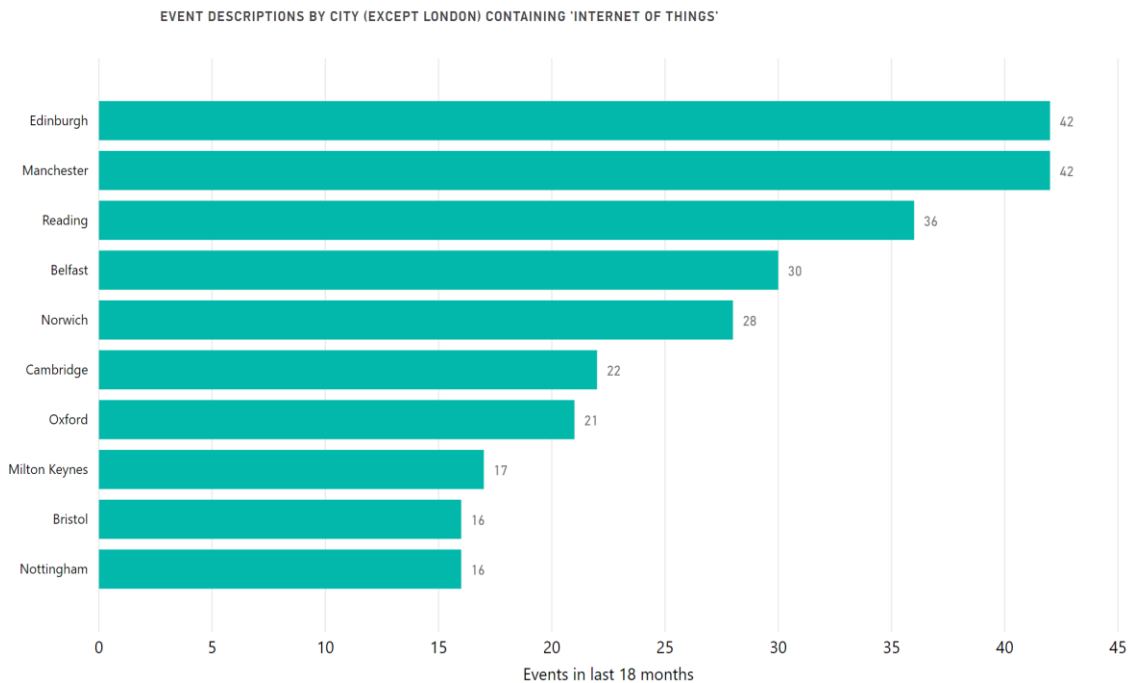
Events

- ⁴¹ **Manchester hosts the [second highest volume of events \(37\)](#) in IoT.** In comparison to other cities, Edinburgh hosts the most (48) and Cambridge is a close third (36). These events have been collected from *Eventbrite* and *Meetup* since January 2018.
- ⁴² However, when we dive deeper into the data, **when searching for events descriptions which contain the keywords 'internet of things' we can see Manchester is the joint top ranked city with Edinburgh (42 events).**

Keyword Data Visualisations

When we look closer at the IoT landscape we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data assets using the following keywords that can be considered in their widest sense to be related to and impacted by events surrounding IoT.



Examples

Most notably, inspired by the London meetups, monthly meetings which discuss ideas on the Internet of Things are organised within Manchester by the [Internet of Things: Manchester](#) group. In this group there are over 1500 members. Manchester has hosted over 120 different events over the last 18 months and next year (at the end of March), Manchester will host the [Industry 4.0 Summit and Expo](#) which will showcase the latest products and services for Industry 4.0, IoT, smart factories and the future of manufacturing.

⁴¹ Outside of London, using The Data City's events explorer, comparing IoT events to other cities in the UK.

⁴² Using The Data City's keyword data visualisations

MedTech

Introduction

Our work analysing 500 thousand technology events, 200 million scientific papers and patents, and 3.8 million web presences of UK registered companies has surfaced a significant strength of Greater Manchester — MedTech.

Why is MedTech important to Manchester?

MedTech and medical device technology is another rapidly emerging and developing sector being disrupted by the application of consumer technology, data and digital services to the domains of health and social care.

Manchester with its broad and deep capabilities (as evidenced in our data) across the emerging technologies sectors is very well placed to develop and grow successfully in the MedTech sector. In addition, the unique nature of the devolved responsibilities for Health & Social care in Manchester means that the funding and political landscape is primed to support this important emerging global sector.

Organisations

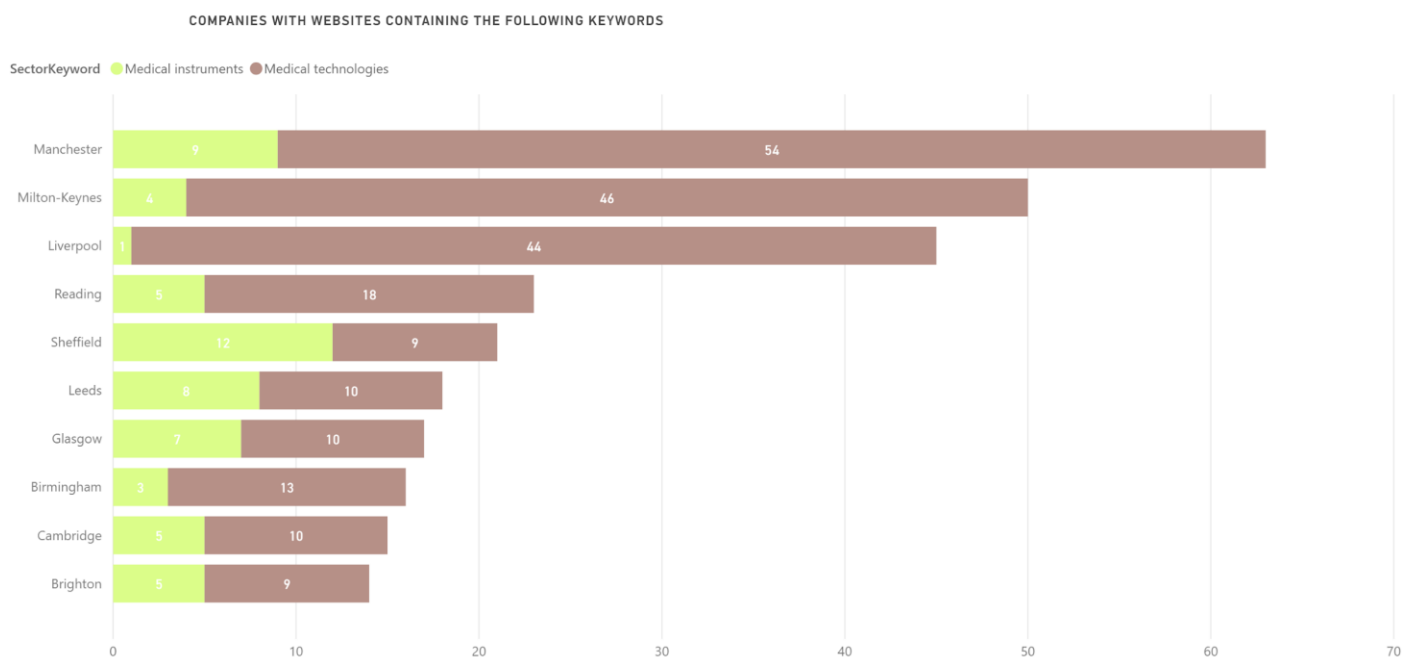
In early 2019 The Data City reached a key milestone; successfully classifying, using machine learning and AI, over 1 million UK organisations into their relevant industries.

- ⁴³[Manchester is the joint top city with the number of organisations that have been classified as MedTech](#) (Oxford is the other joint top city with 20).
- ⁴⁴**Manchester ranks first in the number of organisations websites which contain keywords relating to MedTech.** Manchester has just over 60 organisations linked to MedTech which is substantial compared to the likes of Reading and Leeds, 23 and 18 respectively.
- **Of the organisations with websites that contain the keywords 'Medical technologies', 82.7% of organisations contain the keyword 'idea' and 44.9% contain the keyword 'collaboration'.** This suggests the link between Manchester's academic and medical presence is very strong.

Keyword Data Visualisations

When we look closer at the MedTech landscape we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data asset using the following keywords that can be considered in their widest sense to be related to and impacted by organisations involved in MedTech.



Examples

Due to the rise in medical device technology, there has been a significant rise in the number of MedTech organisations, [technology is changing healthcare](#) in ways that were scarcely imaginable only five years ago. An example of a new MedTech organisation in Manchester is [DeepMed.io](#) which specialises in Histopathology, their modular AI-powered decision support system enables

⁴³ Using The Data City's machine learning classification of organisations, outside of London.

⁴⁴ Outside of London, using keywords: Medical instruments and Medical Technologies.

histopathologists to perform certain diagnostic tasks faster and with greater accuracy. In September, DeepMed IO made it to the top 10 teams in the world in metastasis detection on breast cancer using AI. Another notable example of an industry-leading company in Manchester is [Lig-Biowise](#), who are building a diagnostic technology that can be used at the point of care to identify multiple pathogens simultaneously. Their data driven research has led to the innovation into diagnostic devices which could feed data to an anonymised cloud network capable of mapping pathogen levels geographically.

Research

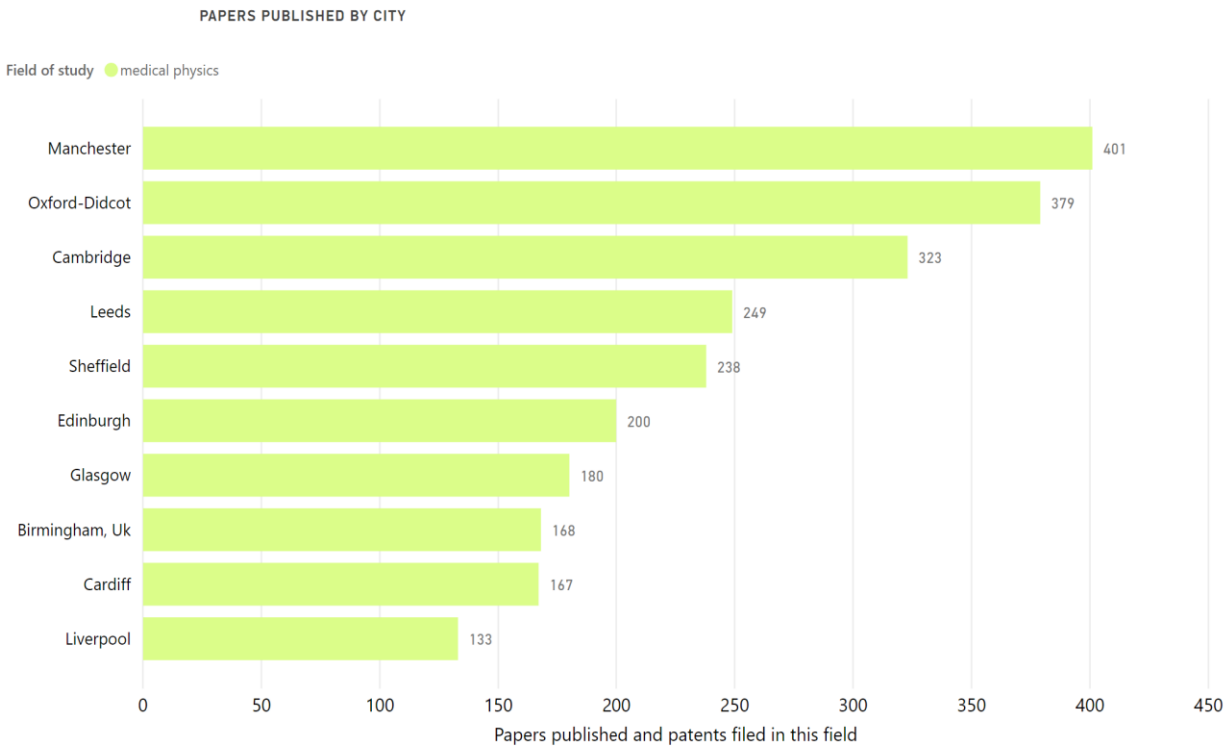
The Data City's Data demonstrates that, outside of London, Manchester is delivering a substantial amount of research in medical physics, a key aspect of MedTech.

- The sheer volume of research in Medical Technology in Manchester is impressive.
⁴⁵**Manchester has released 401 different papers and patents related to this field which makes Manchester the top ranked city.** Oxford (379) and Cambridge (323) follow in a close second and third.
- Although Manchester is producing the most (outside of London) papers published in medical physics, **it is the second top ranked city in the total number of citations and patents filed in medical physics.** Oxford has been cited 12,800 times compared to Manchester (8,700) and Cambridge (6,400).

Keyword Data Visualisations

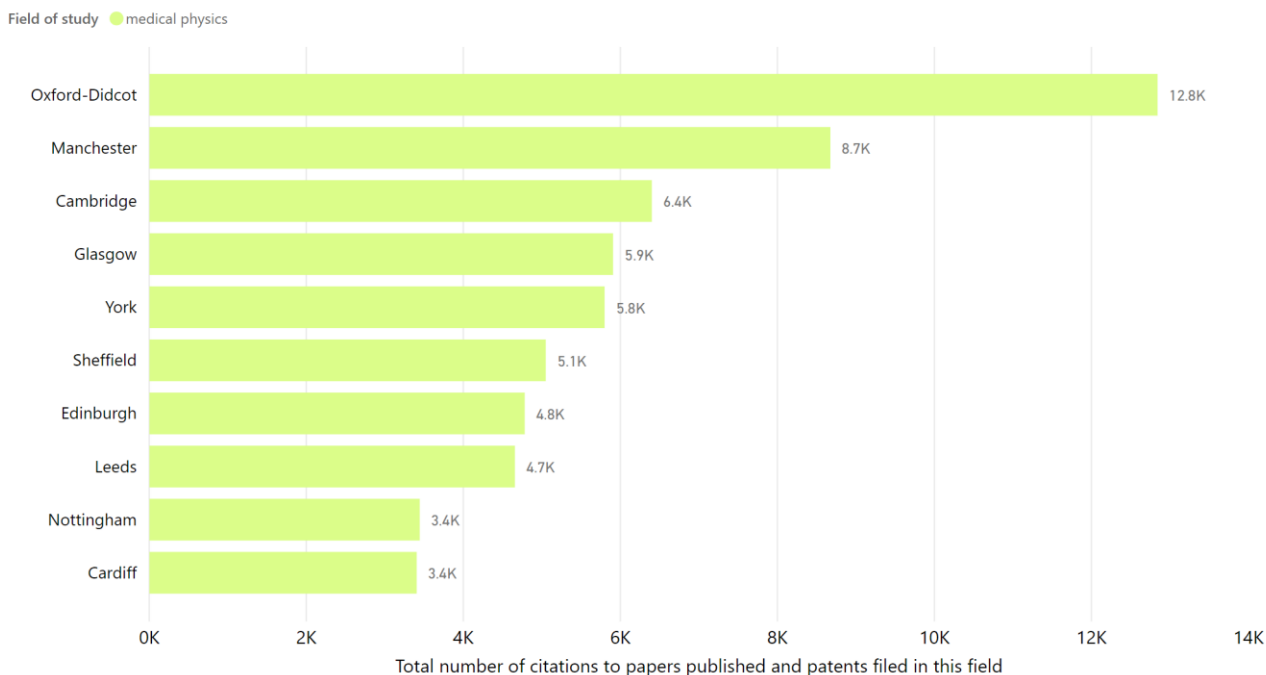
When we look closer at the MedTech landscape we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data assets using the following keywords that can be considered in their widest sense to be related to and impacted by research surrounding MedTech.



⁴⁵ Outside of London.

CITATIONS TO PAPERS PUBLISHED BY INSTITUTIONS IN EACH CITY



Examples

[Manchester: Improving Medicine with Innovation and Technology](#) (MIMIT) works with academics to develop unmet need solutions in collaboration with clinicians and industry and source funding for research. In February, Femeda Ltd (in association with MIMIT) won the [Partnership with Academia Award](#), this is an outstanding example of the way research is integrating with business within Manchester. There is a wide variety of research in Manchester, for example: Located in the heart of Manchester Science Park, The [MedTech Centre Incubator \(MTCi\)](#) is a specialist business incubator for innovators developing technologies which can help the NHS to provide high-quality, efficient care to its patients.

Mohiuddin, Syed G., et al. "Use of Value of Information in UK Health Technology Assessments."

International Journal of Technology Assessment in Health Care, vol. 30, no. 6, 2014, pp. 553-570.

Firth, Joseph, et al. "Mobile Phone Ownership and Endorsement of 'MHealth' Among People With Psychosis: A Meta-Analysis of Cross-Sectional Studies." Schizophrenia Bulletin, vol. 42, no. 2, 2016, pp. 448-455.

Events

- ⁴⁶**Manchester hosts the [highest volume of events \(16\) in MedTech](#).** In comparison to other cities, Cambridge hosts the second most (8). These events have been collected from *Eventbrite* and *Meetup* since January 2018.
- In comparison to the volume of research and the number of organisations within Manchester which are specialising in Medical Technology, the number of events is somewhat lacking.
- ⁴⁷**Manchester is the fifth top ranked city hosting events with descriptions where 'MedTech' is mentioned.** Bristol, Cambridge and Birmingham ([where MedTech expo 2020 is being held](#)) are a few examples of UK cities hosting more MedTech events.

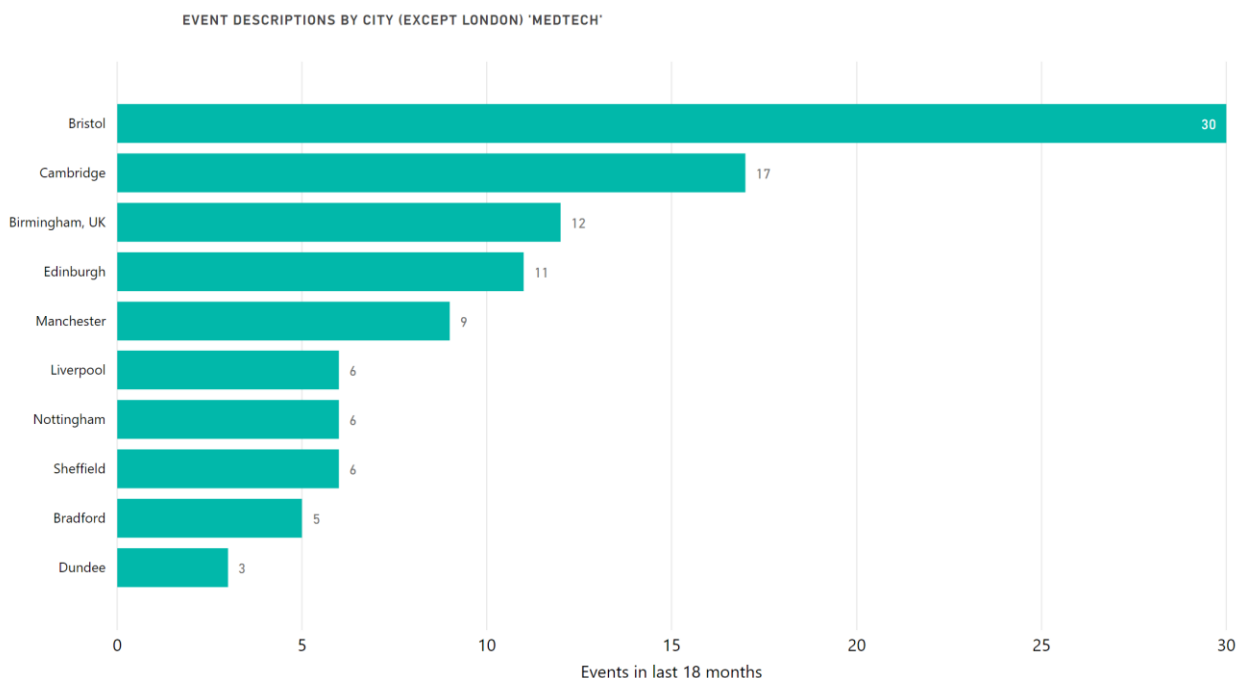
⁴⁶ Using The Data City's events explorer, comparing MedTech events to other cities in the UK, outside of London.

⁴⁷ When using The Data City's keyword data visualisations supplied.

Keyword Data Visualisations

When we look closer at the MedTech landscape we can start to explore deeper and interrogate the Data City data assets using keyword analysis to support our classification process.

Data City completed analysis of its data assets using the following keywords that can be considered in their widest sense to be related to and impacted by events surrounding MedTech.



Examples

Health Innovation Manchester holds a well-documented [archive](#) of the past MedTech events in Manchester and it is clear the number of events being held monthly is rising, this suggests significant progress combining ideas and expertise. A great example of this is [Health 2.0 Manchester](#), which is a meetup group focused on innovations in the delivery of healthcare and health related technology which has attracted over 650 members.

Appendix A

Data Supplied to MIDAS

1. The Data City Emerging Technology Summary Report
2. MIDAS Recommended Organisations (long list and short list)
3. GMCA, MIDAS, HATCH, TheDataCity, PowerBI Document

This report is an extensive 65 page report which explains why Manchester has such a strong digital presence within the UK. The report also provides MIDAS new data sources which MIDAS can subsequently use to create a marketing proposition for Greater Manchester's Inward Investment activity and identify target organisations for inward investment. The report provides an overview which provides context then supplies a matrix table in which it clearly shows Manchester's digital strengths. 8 areas have been identified which are then fully explained in the report. The strength of each area is explained using the following format with data provided by The Data City:

- An introduction
- A description as to why the subject area is important
- A description of why organisations are important, this includes:
 - Key facts
 - A link to [The Data City's organisations explorer](#), an online tool which allows the user to filter by sector and by city
 - Keyword data visualisations
 - Supporting desk based research
- A description of why research is important, this includes:
 - Key facts
 - A link to [The Data City's innovation explorer](#)
 - Keyword data visualisations
 - Supporting papers
- A description of why events are important, this includes:
 - Key facts
 - A link to [The Data City's event explorer](#)
 - Keyword data visualisations
 - Supporting examples

MIDAS Recommended Organisations (long list and short list)

The Data City uses organisation classifications to identify those which could be suited to Manchester's thriving digital economy. In this google sheet, a long list of around 100 companies which have been split into different sectors have been provided to MIDAS. Supporting desk based research has located these organisations and researched the feasibility of a potential relocation or potential digital relocation to Manchester. The google sheet also includes the organisations employer size, website, GMCASIC Grouping and sector score, thus making it easy to filter on the users requirements. Sector score refers to the quality of the fit, the score is arbitrary, however, the higher the score, the more likely a better fit for Manchester's digital economy. Additional Manufacturing, Health, Health Innovation, Financial and Creative sector targets have been met required by MIDAS. Additional comments from MIDAS have been added in order to create a final 40 company short list.

GMCA, MIDAS, HATCH, TheDataCity, PowerBI Document

The Power BI explorer is [available for download](#) now and should open in Power BI complete with data and the following pages.

The underlying data is contained within the Power BI document and at the links contained within it. Use of this data is governed by the The Data City data sharing agreement.

The Power BI pages are split into sections that are almost exact replicas of the following online tools – while offering greater flexibility and access to raw underlying data:

1. <https://www.thedatacity.com/products/gmtechprofile/events-explorer/>
2. <https://www.thedatacity.com/products/gmtechprofile/innovation-explorer/june2019/>
3. <https://www.thedatacity.com/products/gmtechprofile/organisations-explorer/june2019/>
4. <https://www.thedatacity.com/products/gmtechprofile/targets/>

Events

1.a Events Explorer.

1.b Tech for Good Events.

A page highlighting the possibilities of complete text search within event descriptions to show that Manchester has an unusually high number of tech for good events.

1.c Service Design Events.

A page highlighting the possibilities of complete text search within event descriptions to show that Manchester has an unusually high number of service design events.

1.d Cyber Events.

A page highlighting the possibilities of complete text search within event descriptions to show that Manchester has an unusually high number of cybersecurity events.

Papers and patents

2.a Papers and patents.

2.b Paper rankings.

This explorer shows which fields of scientific study Manchester leads the world and leads the UK in. Notable strengths are in advanced materials related fields, electricity generation systems, computer science, advertising and commerce, and many areas of social science and economics.

Organisations

3.a Organisations Explorer (ML Sectors).

3.b Organisations Explorer (Sector keywords).

This page shows how innovation keywords found on the websites of companies can be searched for to identify strengths in a place. For example, Manchester notably overachieves on “E-commerce” and “Advanced Materials” while Birmingham notably overachieves in Connected and Autonomous Vehicle categories. Cambridge is typically an enormous overachiever in bioscience related fields.

3.c Organisations Explorer (Innovation keywords).

This page shows how innovation keywords found on the websites of companies can be searched for to identify strengths in a place.

Relocation targets

The following four pages show how our long list of 100 companies undergoing digital transformation was assembled.

4.a Relocation Targets (Business services, manufacturing and digital companies with strengths in Cyber).

4.b Relocation Targets (Construction with strengths in AI & Data and Digital).

4.c Relocation Targets (Retail and wholesale businesses with strengths in AI & Data and Digital).

4.d Relocation Targets (Manufacturing and Health with strengths in AI and Data and Digital).

This list has since been reduced to 40 target companies.

(extra) Organisation location example

5. Example organisation locations (ARM and Deloitte).

This extra example shows the power of our website scraping technology to better understand the operating locations of companies with a single registered address but multiple operating addresses. This technique does not work with all companies, but does for many including ARM Holdings and Deloitte LLC as in this example.