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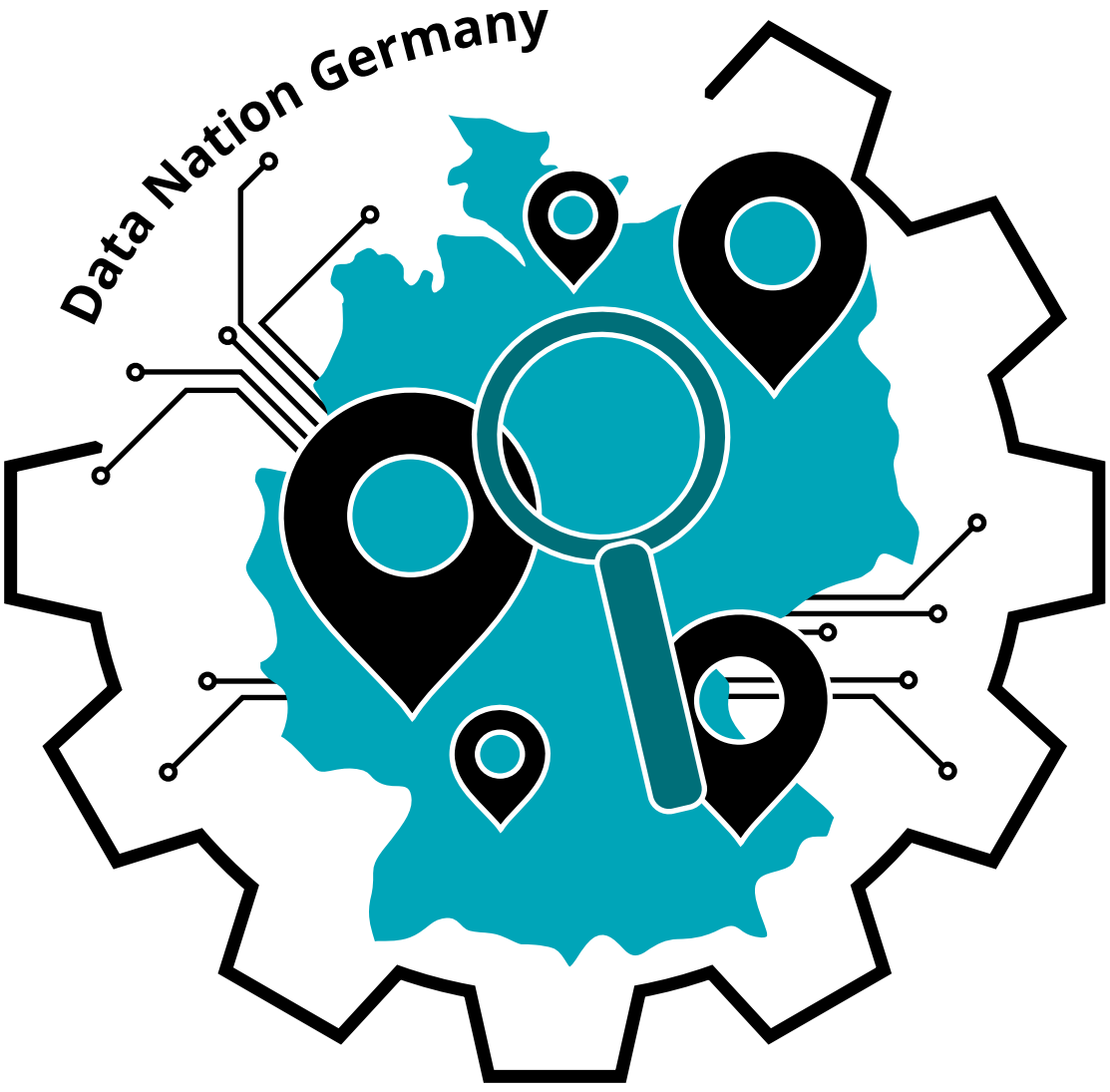


Germany's Digital Hubs

The Geography of the Tech Talents

Preface

Digital hubs are emerging around the world: Besides San Francisco and Silicon Valley, which have been digital pilgrimage sites uncontested for decades, many pioneers have also long since been moving to cities such as Austin, Tel Aviv or Shanghai. When it comes to digital innovations and the best brains who create these innovations, cities need to offer much more than just a fancy image – it is about their sustainability as business locations.

And what does the look at Germany reveal? Which locations are leading in the digital economy? Where does digital innovation take place? And: How well are German cities positioned for the digital future? The answers are provided by our recent study from the "Data Nation Germany" series. One thing is for sure: Munich and Berlin are Germany's leading tech hubs. They are particularly appealing to digital talents and impress with a high specialization in the ICT industry. This makes these two metropolitan regions best equipped to face the future.

What is important here? Innovations In the digital economy require wide networks. New developments will originate where knowledge and experience are shared. To cities, it is more important than ever to create successful ecosystems for both digital and traditional industries: A "sustainable" Germany needs cities and municipalities that take a holistic view of our digital lives and our digital economic power: This involves much more than just modern, digital infrastructures – which undoubtedly is an important aspect. It is also a matter of attracting the best tech talents. It is a matter of first-class education and research facilities, an attractive framework for venture capitalists, a high-quality environment with opportunities for leisure activities and cultural events. And it is a matter of using valuable resources efficiently and sustainably.

One thing is sure: The competition between locations will take place in future even less among the German tech hubs. Their success in the global competition will depend on their capability to find special niches in the digital economy and to make full use of existing strengths. Digital innovations call for international ecosystems to be set up. Regions that manage to build bridges to other digital hubs will be among the winners. Companies also essentially need to open up and digitize their ecosystems. The means to reach this end includes strategic alliances, co-operations or the on-site presence at the right innovation locations of their sectors.

The tasks and challenges are huge. Therefore, topics of the future such as Artificial Intelligence, Internet of Things and Robotics need to be at the top of the agenda and to be dealt with systematically. This is the only way to make full use of the enormous potential for economic and social prosperity associated with these topics.

I hope you enjoy reading this study.

Martin Plendl
CEO Deloitte

Executive Summary

The digital transformation moves technology to the center of economy and business. This also has an impact on the success factors of business locations. Digital innovation is focusing globally and nationally on a few locations (tech hubs), which attract tech talents and allow digital innovation to occur.

The present "Data Nation Germany" study analyses where tech hubs in Germany are located, how the German metropolitan regions compare with each other and whether they offer good prospects. The Tech Hub Index developed for this analysis consists of two main components and 15 indicators: the Tech Hub Status Index measuring the current performance, and the Tech Hub Potential Index which examines the future potential of the 50 largest German metropolitan regions.

The key results of the study are as follows:

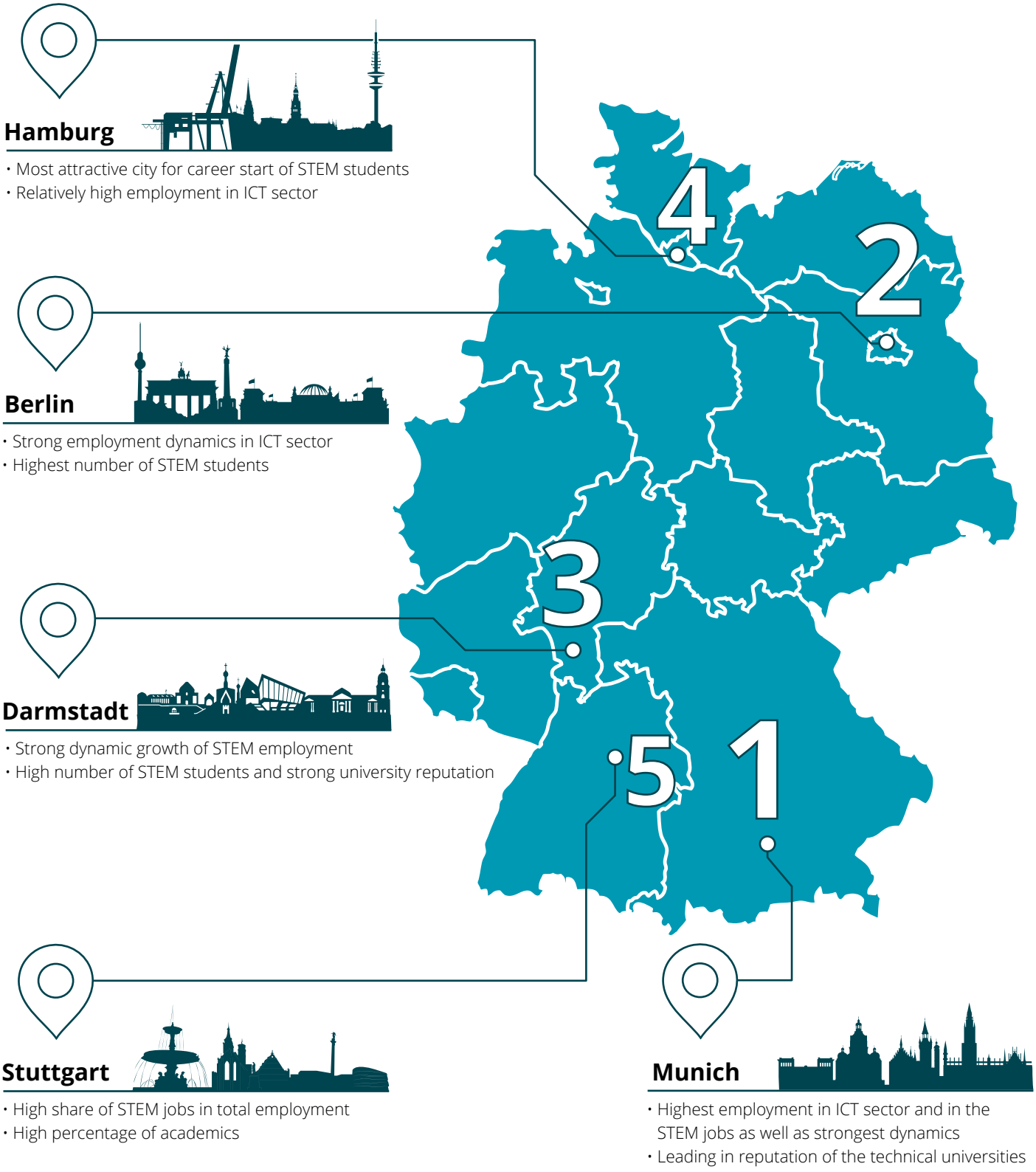
- The concentration of tech talents contributes to urban prosperity. There is a close correlation between the local number of technological jobs and the per capita income in German cities.
- Overall, **Munich** is the key tech hub in Germany and heads the ranking of both status index and potential index. Munich boasts the highest level of specialization in the information and communications technology (ICT) sector, has the highest number of STEM (i.e. science, technology, engineering, mathematics)[1] jobs, and moreover reveals sustained dynamics in these areas.
- **Berlin** is the second most important German tech hub. The German capital is highly specialized in the ICT sector and boasts the highest number of technology students. Major German cities also represented in the top 5 are Hamburg and Stuttgart.
- Besides the "Big 2" (i.e. Munich and Berlin), quite a number of smaller cities have established themselves as tech hubs. These hidden champions are led by **Darmstadt** ranked third. Darmstadt leads the field in research and education as well as in technology jobs. Other hidden champions also stand out due to their leading position in research and education or due to their technology-oriented economic structure. This group of cities include, in addition to Darmstadt, **Erlangen, Karlsruhe** and **Aachen**.
- In the digital economy, cities and locations mainly compete for talents. The international competition between locations in the digital economy and thus the increasing specialization is becoming a challenge for the future to be faced by cities and locations. Companies need to make sure that they are represented in the ecosystems relevant to them, if they want to drive digital innovation in a leading position.

[1] Our definition of STEM jobs also includes computer science jobs

Tab. 1 – Results of Deloitte Tech Hub Index for the German Top 30 Metropolitan Regions (out of 50 in total)

Rank	City	Tech Hub Status Rank	Tech Hub Potential Rank
1	**Munich**	**1**	**1**
2	**Berlin**	**2**	**3**
3	**Darmstadt**	**9**	**2**
4	**Hamburg**	**8**	**4**
5	**Stuttgart**	**6**	**5**
6	**Erlangen**	**3**	**9**
7	**Dresden**	**4**	**8**
8	**Frankfurt am Main**	**8**	**12**
9	**Karlsruhe**	**12**	**7**
10	**Aachen**	**18**	**6**
11	Nuremberg	5	21
12	Münster	17	13
13	Cologne	10	20
14	Regensburg	11	17
15	Hannover	21	11
16	Bonn	14	14
17	Düsseldorf	13	18
18	Leipzig	16	15
19	Heidelberg	25	12
20	Ulm	22	19
21	Mainz	20	24
22	Braunschweig	19	30
23	Freiburg im Breisgau	24	22
24	Mannheim	15	36
25	Kiel	30	23
26	Augsburg	27	28
27	Bremen	35	16
28	Paderborn	31	26
29	Tübingen	29	33
30	Oldenburg	34	32

Fig. 1 – Top 5-Map



Background – Digital Innovation, Tech Talents and Locations

This study answers three key questions: Which German locations are leading in the digital economy? Where is digital innovation taking place? And how well are the German cities positioned for the digital future?

Digitalization versus geography

Geography and distances seem to be irrelevant in the age of digital transformation. The availability of information in any location and its virtually free transmission around the globe are practically an essential part of digital technologies and their economic effects.

At the local level, however, it is exactly the opposite, as the digital economy is geographically concentrated to an extremely high degree. The Silicon Valley is just the most prominent example. There are diverse reasons, which, however, are mainly based on two factors: the profound change in the innovation patterns within companies and the characteristics of the job markets for tech talents in the digital economy.

Innovation and changing tech job markets

Innovation patterns change because digital innovation does not only take place in corporate research departments, but also in regional ecosystems. Successful ecosystems are local networks of start-ups, research facilities, venture capitalists, experts and companies that are in continuous interaction with one another. When it comes to the development of new knowledge, this interaction requires geographical proximity and personal relationships.

This is true not only for the digital industries. The more traditional sectors are digitalized, the more important ecosystems become where digital technologies are linked to traditional products and services. The digital transformation of the automotive industry by autonomous driving or of the finance industry by FinTech or InsurTech companies are examples of this development.

The job markets for tech talents are also transforming, primarily because there is a shortage of highly qualified talents and the digital skills are differentiating more and more. Digital marketing experts have other training programs and skills as experts for Artificial Intelligence, which results in digital hubs developing a pull effect. The offer on the specialized job markets is larger and tech talents will more easily find jobs, and, what is also important to them, the digital hubs allow them to be closer to the innovation process and to be part of an ecosystem. As a result, knowledge is shared faster – and this leads to higher productivity and ultimately to higher salaries.

No digital innovation without tech talents

Tech talents are the key component of innovation ecosystems, as technology does not function without humans. New ideas, technologies and enterprises can be developed and applied only by highly qualified tech talents. In the digital economy, knowledge is the decisive production factor.

This decisive role of the talents is even enhanced by the fact that the revenue from innovations has increased, specially by the innovation logic in the digital sector, with software being an illustrative example: While the development costs of software are high, the subsequent production costs are negligible compared with non-digital products. This shifts the economic value added towards the development of software and the experts being active therein. This also means that the competition for highly qualified talents with IT skills and mathematical and scientific expertise will continue to increase.

Competition between locations in the digital transformation

The digital transformation has far-reaching consequences not only for enterprises, but also for locations. Firstly, a new locational competition is emerging. Cities and locations have always competed for businesses and capital resources. In the digital economy, they are increasingly competing for talents. Capital and businesses often follow the talents.

Secondly, cities are crucial for digital innovation. The urban ecosystems use infrastructures, training opportunities, research facilities and businesses to provide the operating system for digital innovations; hence, they lay down the necessary framework and transform the economic success factors of locations.

Tech-talents are drivers of urban prosperity

One factor for the prosperity of a city is its appeal to highly qualified employees in general and to tech talents in particular. The shortage of tech talents and their high productivity is reflected in high salaries boosting the urban economy and thereby creating jobs in other sectors.[2] Economists have demonstrated that a job in innovative sectors creates five more jobs in other sectors of the same city.[3]

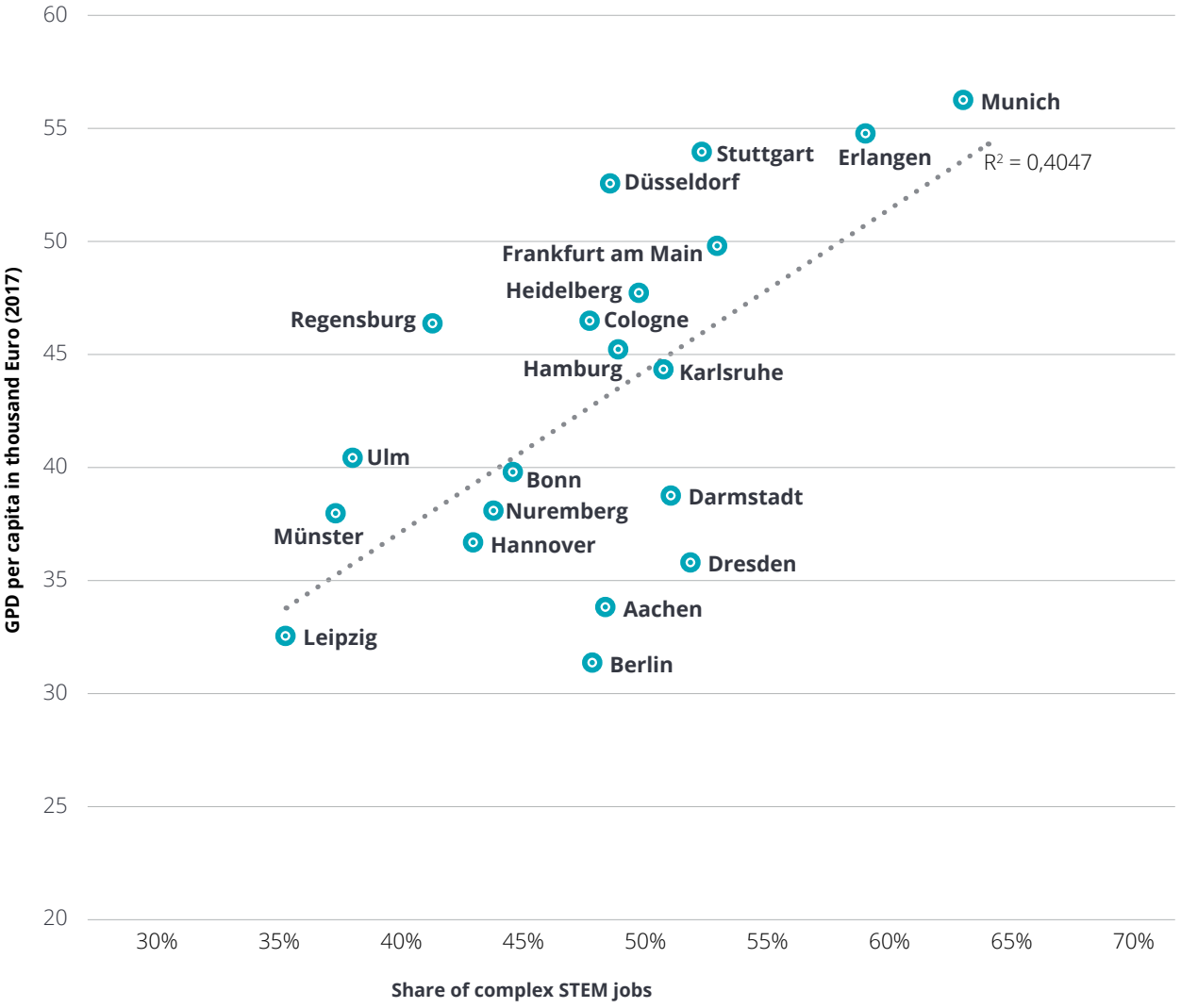
The correlation between urban prosperity and the spread of the tech talents is illustrated in Figure 4, in which the GDP per capita for the 50 largest metropolitan regions in Germany is correlated to the spread of the complex STEM jobs. Complex STEM jobs are those which require academic training.[4]

[2] The academic STEM professionals have, on average, an income more than twice as high as the average workforce and have recently exceeded the income of the business school graduates. STEM Report 2018.

[3] Enrico Moretti 2013. The New Geography of Jobs. New York.

[4] Complex STEM jobs include development, research and diagnostic jobs, knowledge transfer as well as leadership and management functions within a (large) company. The professions require a university education of at least four years and/or relevant professional experience.

Fig. 2 – GDP per capita depending on the share of the complex STEM jobs in the total workforce (2017)



Source: Destatis, Oxford Economics

The close "positive" correlation between urban prosperity and the share of the complex STEM jobs indicates that the added value generated by these professions and by the STEM-intensive industries is high.

Hence, urban prosperity is also driven by the STEM professionals. The more the digital transformation progresses, the more important this correlation is likely to become in the future.

Methodology: Two perspectives on the German Tech Hubs

Against this background, the present study analyses the German tech hubs on the basis of the 50 largest German metropolitan regions from two perspectives. To this end, 15 individual indicators are aggregated into two indices mapping the spread of the tech talents in Germany and thus different dimensions of tech hubs.

- Tech Hub Status Index: The focus of the Status Index is on which locations are the currently leading digital locations in Germany;
- Tech Hub Potential Index: the second perspective aims at highlighting the prospects of the German tech hubs.

The **Status Index** examines the number of the jobs in the STEM (science, technology, engineering, mathematics, computer science) segment, their share in the urban total workforce, and their dynamics, as well as the importance of employment in the information and communication technology (ICT) sector. In addition, the employment rate and the percentage of academics in the cities are depicted.

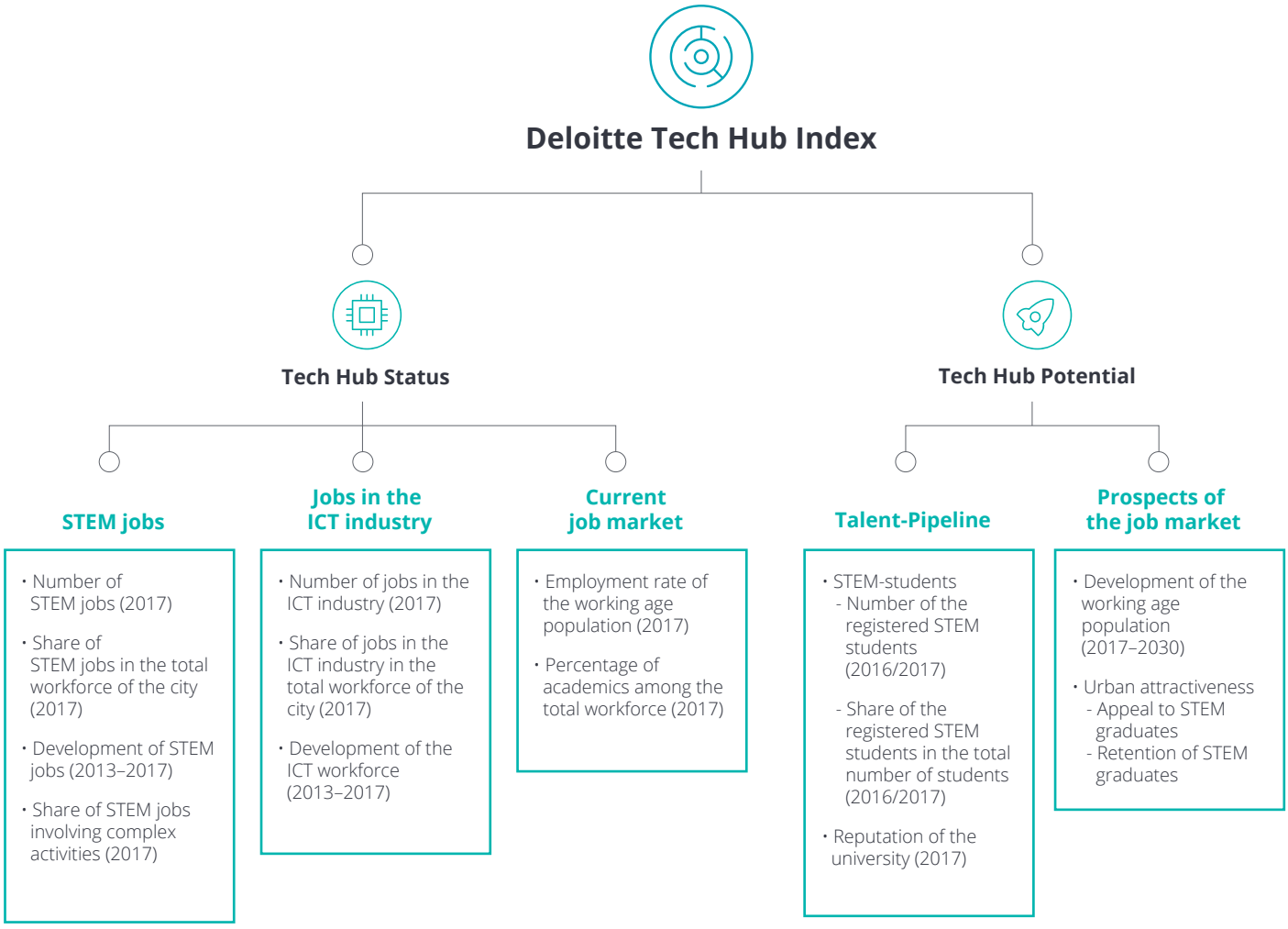
The idea behind the Status Index is that cities are the more competitive in the digital sector, the more strongly the ICT sector is represented as a driver of the digital transformation. However, since the digital transformation left the ICT sector long ago, it is also important to see how concentrated the STEM jobs are in the other sectors.

The STEM talents in the overall economy are vital to the development of digital innovations in traditional sectors. This is paramount especially to the highly industry-related German economy with its showcase sectors of automotive industry, mechanical engineering industry and chemical industry. The application and spread of digital technologies depend on the general level of education in a city measured as the percentage of academics and the employment rate as an approximate indicator of the general economic performance.

The **Potential Index** measures how these indicators will perform in the future. Here, it is valid that the prospects as a tech location are the better:

- the more STEM students are shown by the location – in absolute terms and as a percentage of all local students;
- the higher the reputation of the local universities is;
- and the higher the force of appeal to and the retention of the present STEM students is. The last two indicators have been measured by a survey specifically designed for the groups of STEM students. Furthermore, the projected job market dynamics until 2030 is added as proxy for future economic development.

Fig. 3 – Structure of the Tech Hub Index



This study analyses the German tech hubs on the basis of the 50 largest German metropolitan regions from two perspectives: The current status of the respective metropolitan region and its prospects until 2030.

Results: The leading German tech hubs

The Big 2 and the large cities

The Metropolitan region of Munich is by far the most important German tech hub. This region takes first or second place in 11 of the 15 indicators and thus leads both the status index and the potent index. What is remarkable about Munich's current position in the segment of digital talents is that the city has a very high degree of specialization in the ICT industry and simultaneously offers by far the largest number of STEM jobs across all cities. Hence, Munich leads not only in the originally digital sector, but also in the digital transformation of the traditional sectors. Munich, for example, has a higher absolute employment figure in the ICT sector and in STEM jobs than Berlin with twice as much inhabitants. Despite this very high level, Munich takes the lead even in the dynamics of employment in these fields. The same applies to the share of the complex STEM jobs, the reputation of the universities, the appeal to STEM students and the expected development of the job market by 2030.

Berlin, second in the overall ranking, also takes second place in the status index and third place in the potential index. Berlin especially excels in the dynamics of employment in the ICT sector as well as in the dynamics of employment in the STEM segment and in the absolute number of STEM students, whereas the share of the STEM jobs in the total workforce is very low in Berlin, coming in last with the STEM share as well as with the projected future dynamics in the total job market.

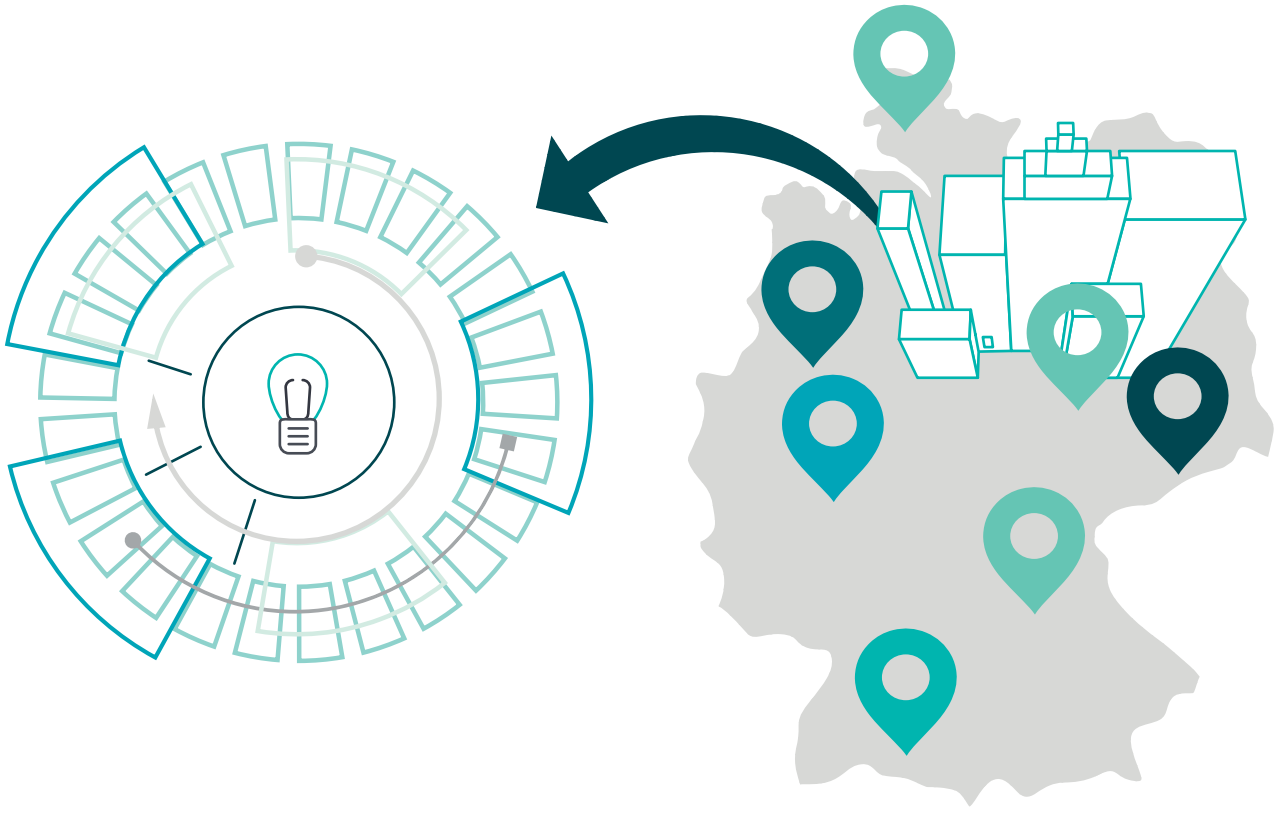
Hamburg, the third German megacity, ranks fourth. The Hanseatic City performs in the potential index significantly better than in the status index and has its strengths in the specialization in the ICT sector, albeit with relatively slow dynamics, and in the appeal to STEM students. Hamburg is followed by Stuttgart, which is strong in the number of STEM jobs, the percentage of academics and the number of STEM students. Of the seven largest German cities, the "Big 7", there is only one more city, i.e. Frankfurt, which has managed to be placed eighth in the Top 10 of the tech hubs.

The hidden champions among the German tech hubs

In the competition between locations, smaller cities may also have good chances. In the German tech ecosystem, a variety of hidden champions has emerged. The third rank of the tech hubs is taken by Darmstadt, outpacing most of the large cites. Darmstadt scores mainly with the status index and here particularly with the absolute and relative share of the STEM students and the university reputation. However, at the same time Darmstadt demonstrates high dynamics with the STEM jobs.

The ranks 6 to 10 show further hidden champions. Erlangen on 6th place has achieved top positions in the share of the STEM jobs in the total workforce, the complex STEM jobs as well as the employment rate and the percentage of academics. A very similar profile is shown by Karlsruhe on place 9, combined with a very strong specialization in the ICT sector and a leading position in the university reputation and the number of STEM students. These strengths in the potential index are also demonstrated by Aachen on place 10 having the third-highest absolute and the highest relative share of STEM students.

These smaller university and science cities, which also include Münster and Regensburg, rank in the index before significantly larger cities like Düsseldorf or Leipzig – not only due to their ranking in the tech hub index, but also due to their being a location for the tech industry. The smaller tech hubs manage to be successful either in the specialization in the ICT sector (Karlsruhe) or in STEM jobs (Regensburg, Erlangen). This may firstly reflect start-up activities, but also the regional economic structure with large companies as is evident from top positions in the segment of STEM jobs.



Tab. 2 – Ranking of the 30 largest German metropolitan regions (out of 50 in total)

Rank	City	Tech Hub Status Rank	Tech Hub Potential Rank
1	**Munich**	**1**	**1**
2	**Berlin**	**2**	**3**
3	**Darmstadt**	**9**	**2**
4	**Hamburg**	**8**	**4**
5	**Stuttgart**	**6**	**5**
6	**Erlangen**	**3**	**9**
7	**Dresden**	**4**	**8**
8	**Frankfurt am Main**	**8**	**12**
9	**Karlsruhe**	**12**	**7**
10	**Aachen**	**18**	**6**
11	Nuremberg	5	21
12	Münster	17	13
13	Cologne	10	20
14	Regensburg	11	17
15	Hannover	21	11
16	Bonn	14	14
17	Düsseldorf	13	18
18	Leipzig	16	15
19	Heidelberg	25	12
20	Ulm	22	19
21	Mainz	20	24
22	Braunschweig	19	30
23	Freiburg im Breisgau	24	22
24	Mannheim	15	36
25	Kiel	30	23
26	Augsburg	27	28
27	Bremen	35	16
28	Paderborn	31	26
29	Tübingen	29	33
30	Oldenburg	34	32

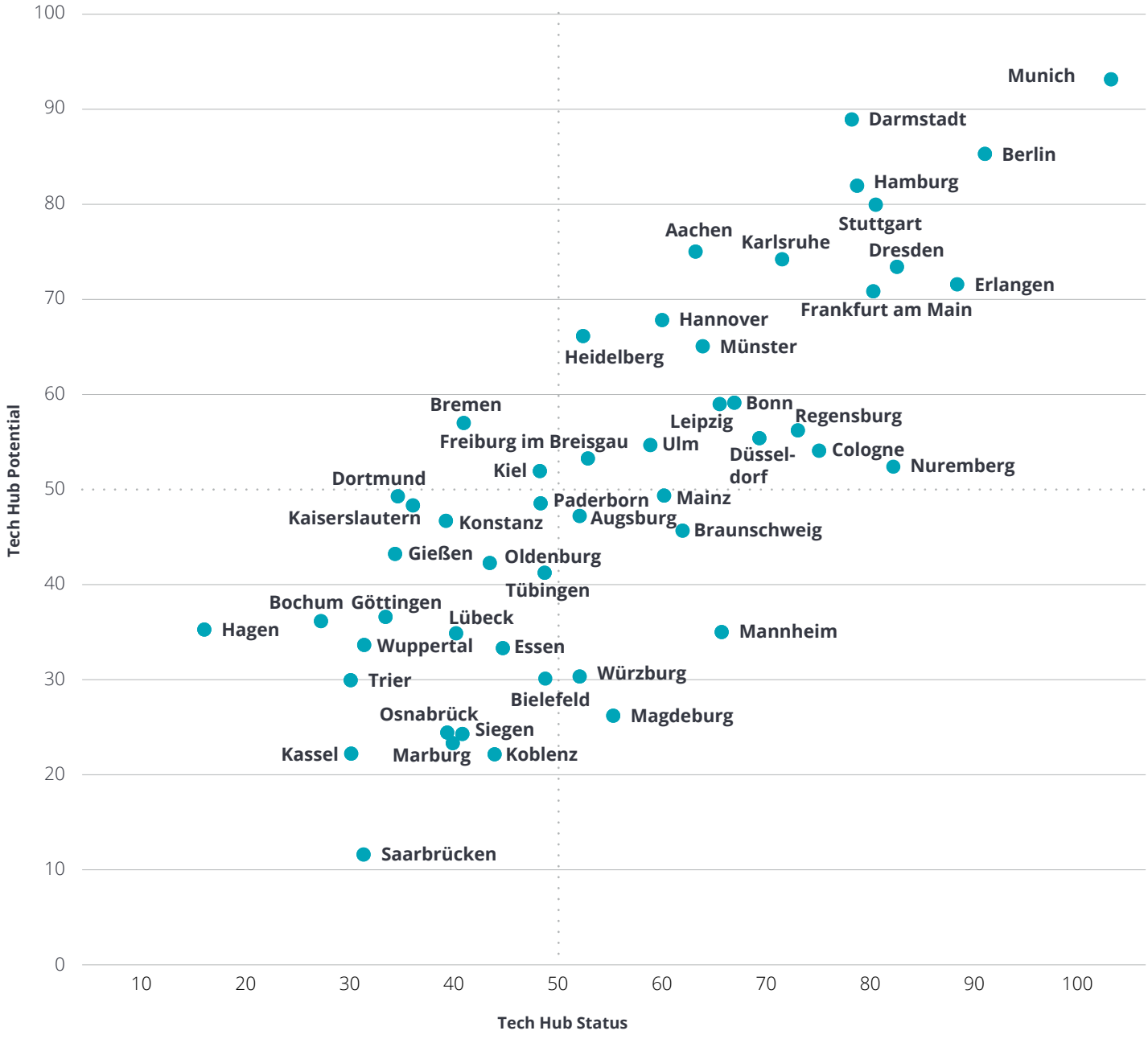
Presence versus future

When combining the two columns of the digital Tech Hub Index, it is apparent that German cities do not only diverge strongly in the current endowment with talents, but are also evolving differently. The cities are grouped around two poles: Firstly, the cities that perform above average both in the status quo and in the potential and can be found in the upper right quadrant (see Fig. 4). Secondly, the cities that underperform in both dimensions.

Hence, there are hardly any cities whose potential is above the status quo and that therefore might be considered as an upcoming tech hub. Moreover, a very close correlation between the current position and the conditions for the future competitiveness can be identified. In this sense, the prospects are largely determined by the starting position.

On the other hand, it became evident that also the leading group of the tech hubs is differentiated. Munich is clearly ahead of Berlin and both cities again are clearly ahead of a group of cities that have advanced to a similar extent – Darmstadt, Hamburg, Stuttgart, Erlangen and Dresden.

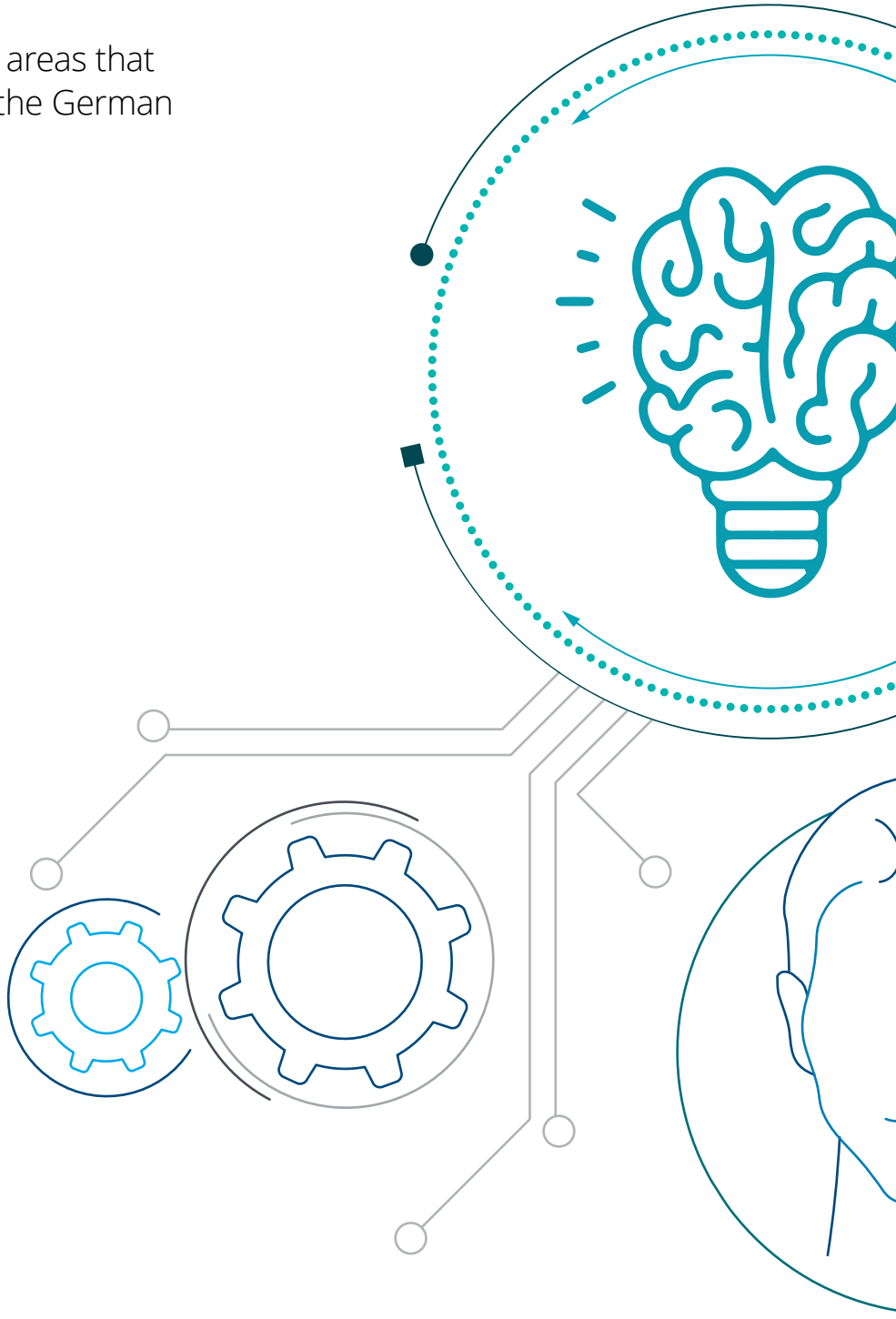
Fig. 4 – Matrix of Tech Hub Status and Tech Hub Potential

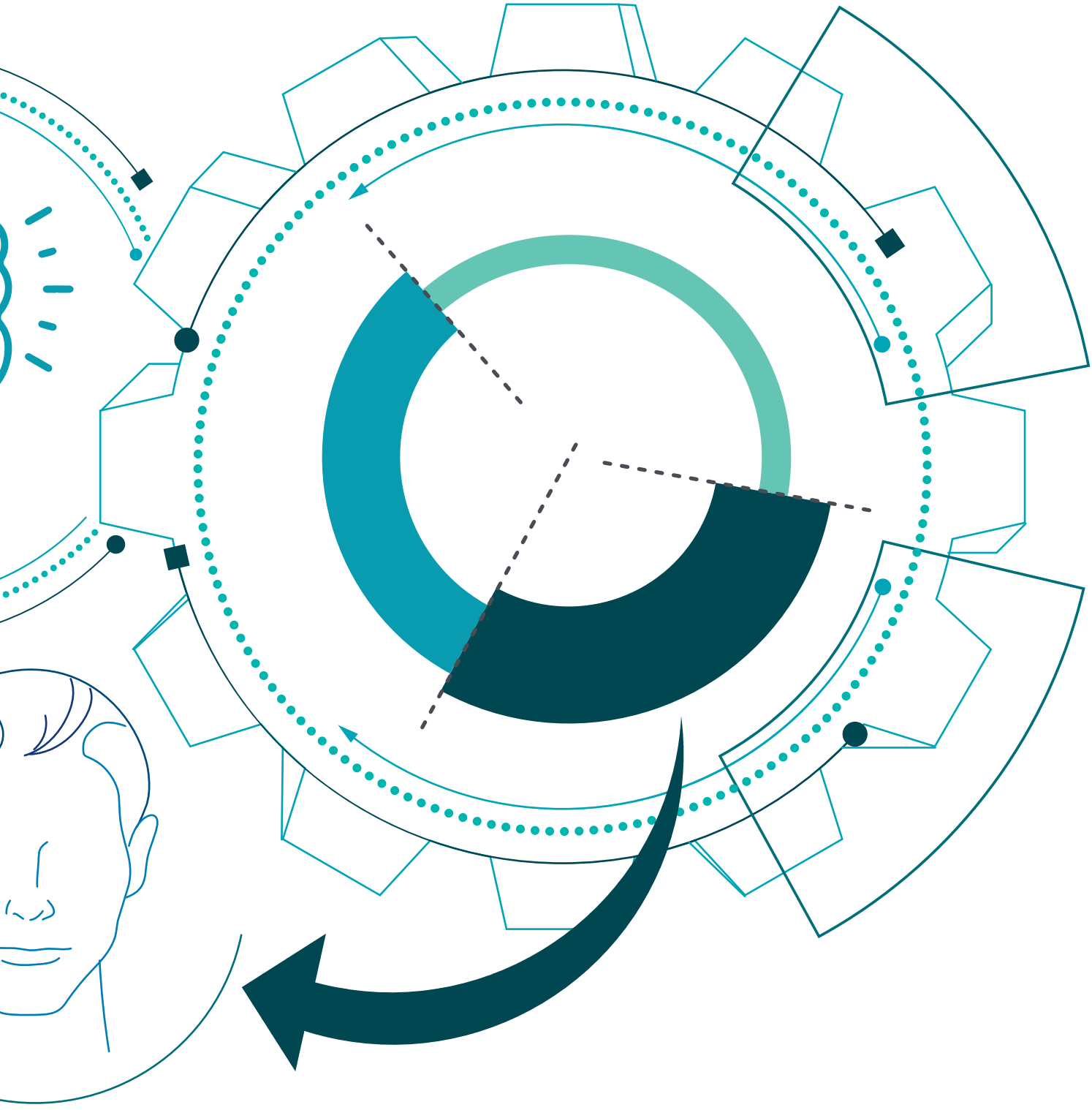


Tech Hub Status Index

The status index includes three areas that map the current capabilities of the German cities in the digital sector.

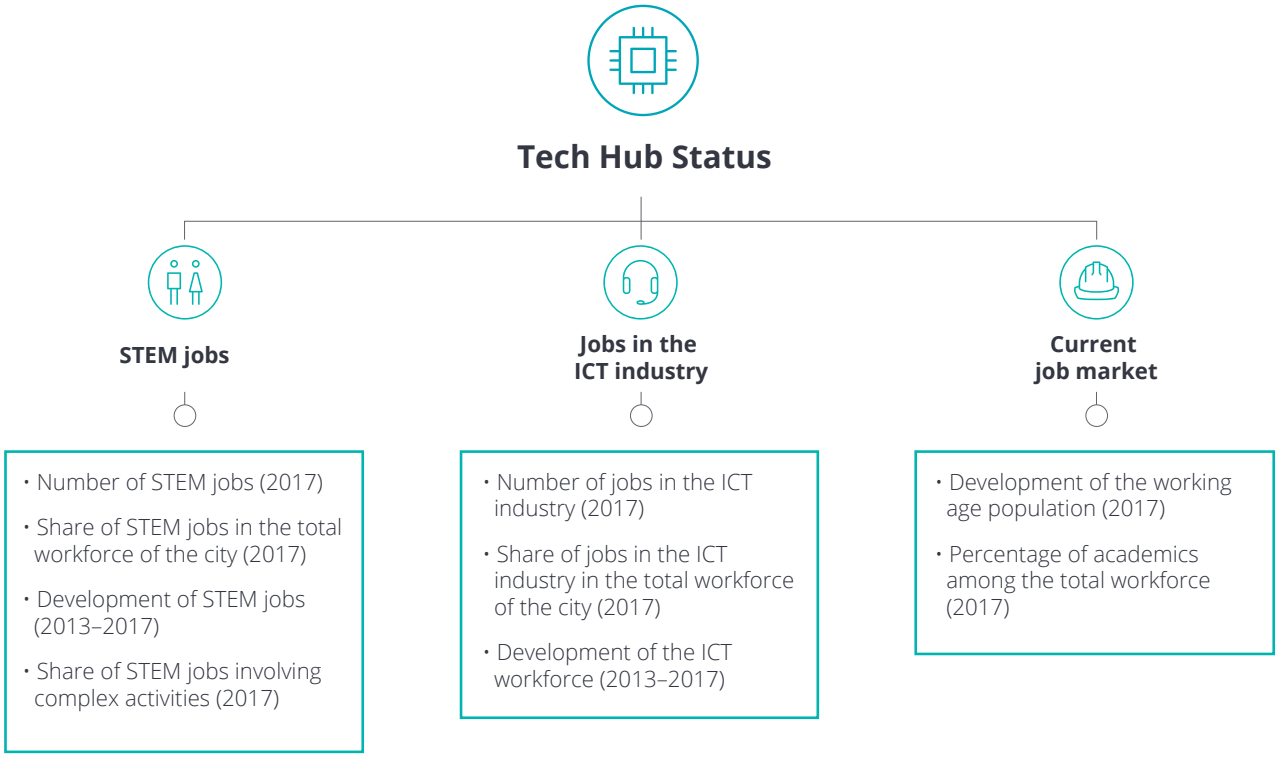
- Firstly, the focus of the German cities on the ICT industry, measured as absolute and as relative employment rate in the ICT industry and as dynamics of employment.
- Secondly, the absolute and relative employment rate and the dynamics of the STEM jobs throughout the urban economy. This is supplemented by the share of complex STEM jobs. This indicator maps the share of STEM jobs of the highest qualification that at least require relevant university studies or a doctorate.
- Thirdly, the general situation on the job market and in respect of the educational level of the population measured as employment rate and percentage of academics.





The Tech Hub Status reflects the different capabilities and priorities of German cities

Fig. 5 – Tech Hub Status



The overall picture reflects the different economic priorities of German cities. Munich clearly leads the list and takes 1st place in all three dimensions. Berlin reveals strengths in the specialization in the ICT industry but underperforms with STEM jobs throughout its economy. The next ranks are held by Erlangen, Dresden, Nuremberg and Stuttgart. These tech hubs take a leading position either with the STEM jobs (Stuttgart, Erlangen) or with the specialization in the ICT industry (Nuremberg), whereas Dresden scores in the fields of job market and level of education.

Tab. 3 – Ranking of the Top 30 Cities

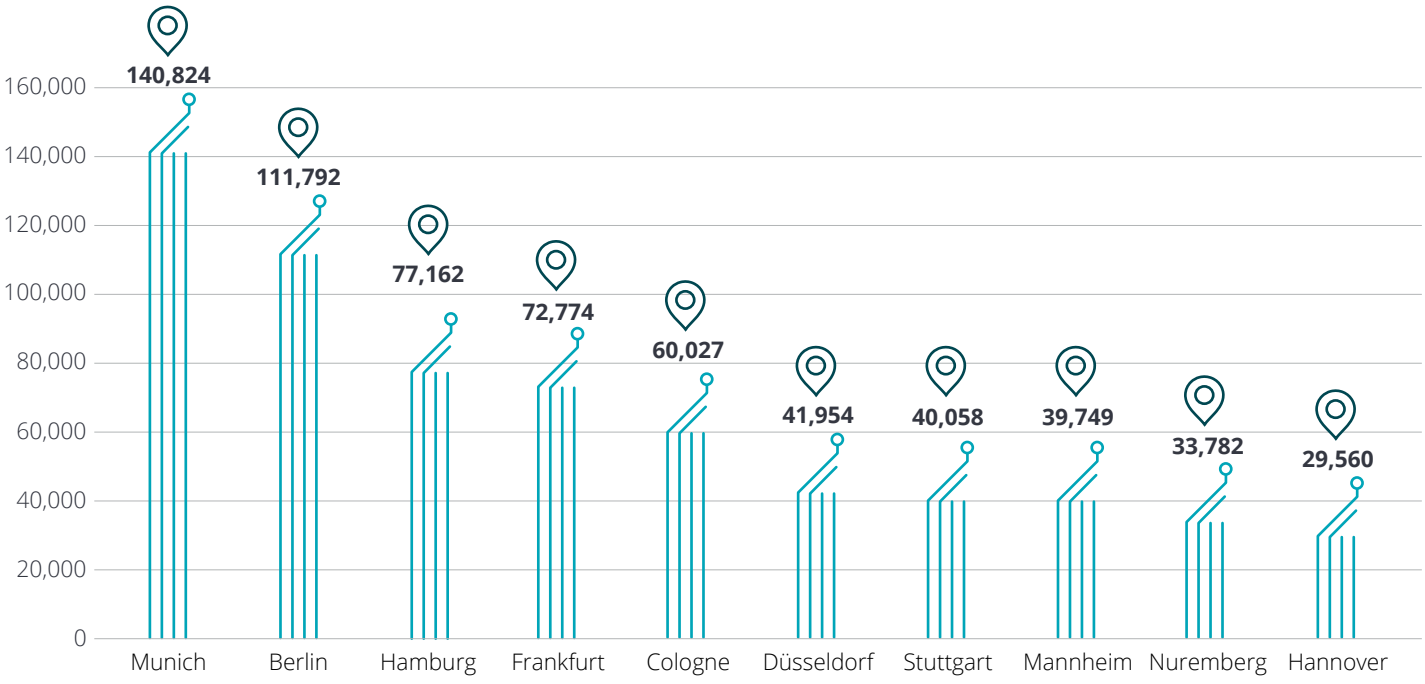
Rank	City	Score	STEM jobs Rank	ICT jobs Rank	Workforce Rank
1	**Munich**	**97**	**1**	**1**	**1**
2	**Berlin**	**85**	**2**	**6**	**5**
3	**Erlangen**	**82**	**11**	**3**	**2**
4	**Dresden**	**77**	**13**	**8**	**3**
5	**Nuremberg**	**76**	**3**	**10**	**11**
6	**Stuttgart**	**75**	**27**	**2**	**4**
7	**Frankfurt am Main**	**75**	**6**	**9**	**7**
8	**Hamburg**	**73**	**4**	**15**	**8**
9	**Darmstadt**	**72**	**14**	**4**	**8**
10	**Cologne**	**70**	**5**	**12**	**18**
11	Regensburg	67	25	5	10
12	Karlsruhe	66	22	7	14
13	Düsseldorf	64	15	18	11
14	Bonn	62	8	20	22
15	Mannheim	60	17	22	17
16	Leipzig	60	29	21	6
17	Münster	59	8	19	27
18	Aachen	58	12	14	29
19	Braunschweig	57	35	11	16
20	Mainz	55	10	39	18
21	Hannover	54	21	24	23
22	Ulm	54	37	16	14
23	Magdeburg	50	16	47	11
24	Freiburg im Breisgau	48	44	16	20
25	Heidelberg	47	41	13	24
26	Würzburg	47	18	41	26
27	Augsburg	47	28	27	24
28	Bielefeld	44	22	33	32
29	Tübingen	44	46	23	21
30	Kiel	43	7	38	43

ICT jobs

Jobs and specialization

The highest degree of specialization in the ICT sector is shown by the metropolitan region of Munich with more than 140,000 employees. The next largest hubs are Berlin, Hamburg, Frankfurt and Cologne. The gap for the ICT jobs between the three leading cities is relatively large: in Munich it is higher by 26 % than in Berlin, where it is in turn higher by 45 % than in Hamburg.

Fig. 6 – ICT jobs



Source: Destatis

Munich and Berlin lead both in terms of the number and growth of STEM jobs. The highest degree of specialization among STEM jobs, however, is found in Erlangen

The second dimension of the ICT specialization is relative to offset the economies of scale of the large cities. It measures the share of the ICT sector in the total workforce. Here again, Munich is at the forefront. The ICT share is the highest with 10 %, followed by smaller tech hubs like Darmstadt, Karlsruhe and Cologne, where the ICT sector accounts for 8 % of the total workforce.

Dynamics

The dynamics of employment in the ICT sector is the highest in Berlin. Between 2013 and 2017, the number of the employees in the Berlin ICT sector was growing the fastest at a rate of 13 %. The German capital is followed by Munich with a rate of 11 % as well as by Erlangen and Nuremberg with 10 % each. By comparison, the employment figures in Stuttgart, Ulm and Bremen stagnated. In Dortmund and Kassel, they even decreased significantly.

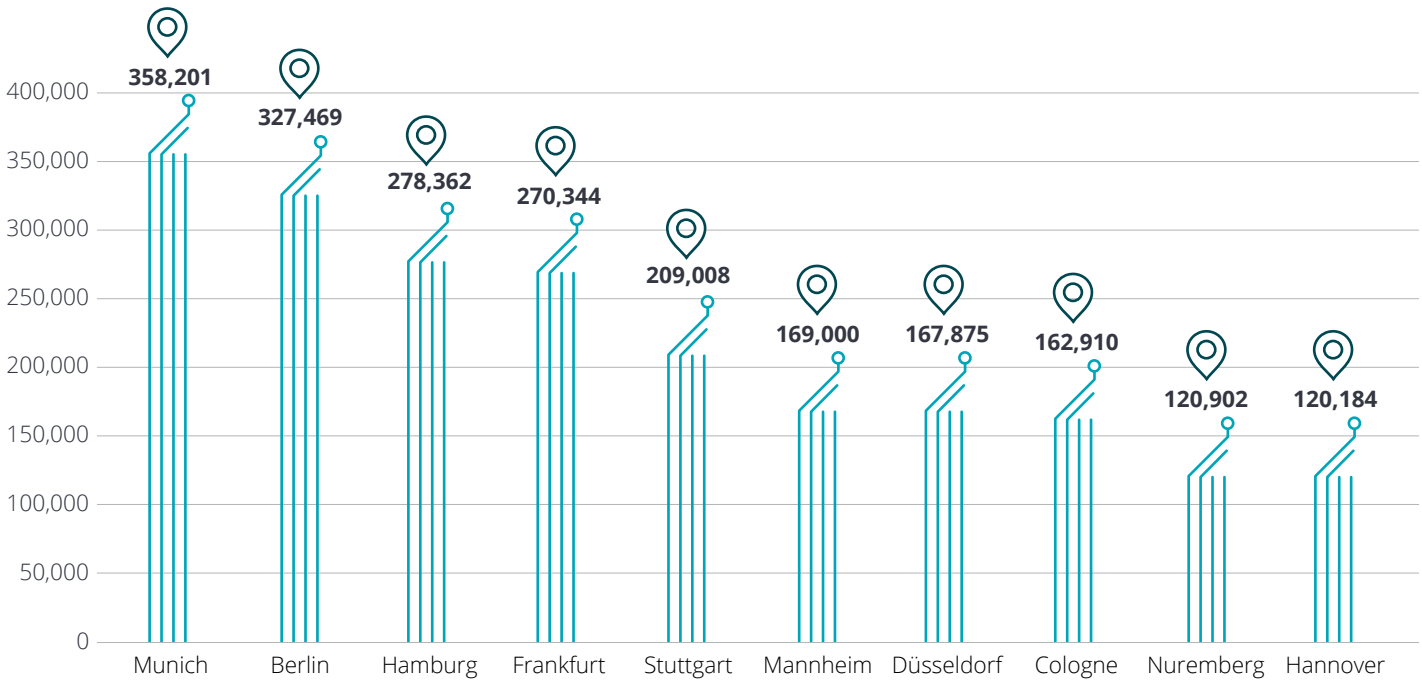
STEM jobs

STEM jobs in the urban economy indicate the technological progress of a location and the dynamics created by this location in technologically oriented sectors. The count of these jobs includes, for example, software engineers or mathematicians in the automotive sector or in the mechanical engineering industry.

Employment and specialization

In absolute employment figures, Munich also leads in terms of STEM jobs. This metropolitan region features 358,000 STEM jobs. Berlin has approximately 30,000 fewer STEM jobs, with Hamburg, Frankfurt, Stuttgart and Mannheim following.

Fig. 7 – STEM Jobs (2017)



Source: Destatis

The city with the highest specialization in STEM jobs, however, is Erlangen. In Erlangen, these jobs (with a ratio of 30 %) account for almost one third of the urban total workforce. This ratio is closely followed by further smaller tech hubs such as Regensburg, Ulm and Karlsruhe (29 % in each case). Among the large cities, Stuttgart shows the highest share of STEM jobs (28 %), followed by Munich (25 %).

Munich, Erlangen, Stuttgart and Dresden do not only show the highest percentage of academics among German cities, they also feature the highest share of STEM specialists within Germany.

Dynamics and complexity

The dynamics of the STEM jobs again is the highest in Munich. Between 2013 and 2017, the number of STEM jobs grew by 14 %. Regensburg is close behind with 13 %, followed by Berlin, Tübingen and Leipzig. The number of STEM jobs, however, is not growing in every location. There are cities where it is declining sharply. Bochum, for example, has lost 10 % of its STEM jobs over the past five years.

On a deeper level, the STEM jobs differ by their complexity.[5] The higher the complexity, the higher the likely innovation potential. Here, Munich and Erlangen have taken a strong lead. In Munich, 63 % of the local STEM jobs show the highest degree of complexity, and in Erlangen it is 60 %. Stuttgart and Frankfurt follow with 54 % before Dresden. In Berlin, the share of jobs with the highest degree of complexity is 49 %. The lowest value is shown by Trier with 27 %.

Job market

The conditions on the job market and the employees' level of education both are key success factors for locations and an approximate value for the appeal of an urban job market and a sufficient workforce that is needed to implement technological innovations.

The employment rate among the German metropolitan regions is the highest in Munich and Erlangen. In both cities, 63 % of the population are in employment. This rate is similar in Dresden and Nuremberg. With 44 % and 51 %, it is the lowest in Heidelberg and Bochum.

A very similar picture is observed in the group leading with the percentage of academics, which depicts the number of highly qualified employees at any location. Munich with 28 % is slightly ahead of Erlangen, Dresden and Stuttgart. The percentage of academics varies significantly between German cities and, for example, is 10 % in Koblenz and 11 % in Trier.

[5] The German employment agencies distinguish four levels of STEM jobs. The most complex level requires university studies of at least four years or a comparable qualification.

Tech Hub Potential Index

The Potential Index maps the prospects of German cities in the digital economy. With this objective, this index analyses the structural factors that will shape the future competitive position in the segment of the digital talents, along two dimensions.

- **Talent pipeline:** This indicator analyses the next Generation of tech talents – today's STEM students – and the locations leading in research and university education in the technology sector.
- **Job market prospects:** The job market indicator examines the probable job market trend in the German cities until 2030 and qualitatively determines the cities that are most appealing to STEM students for their later career start.

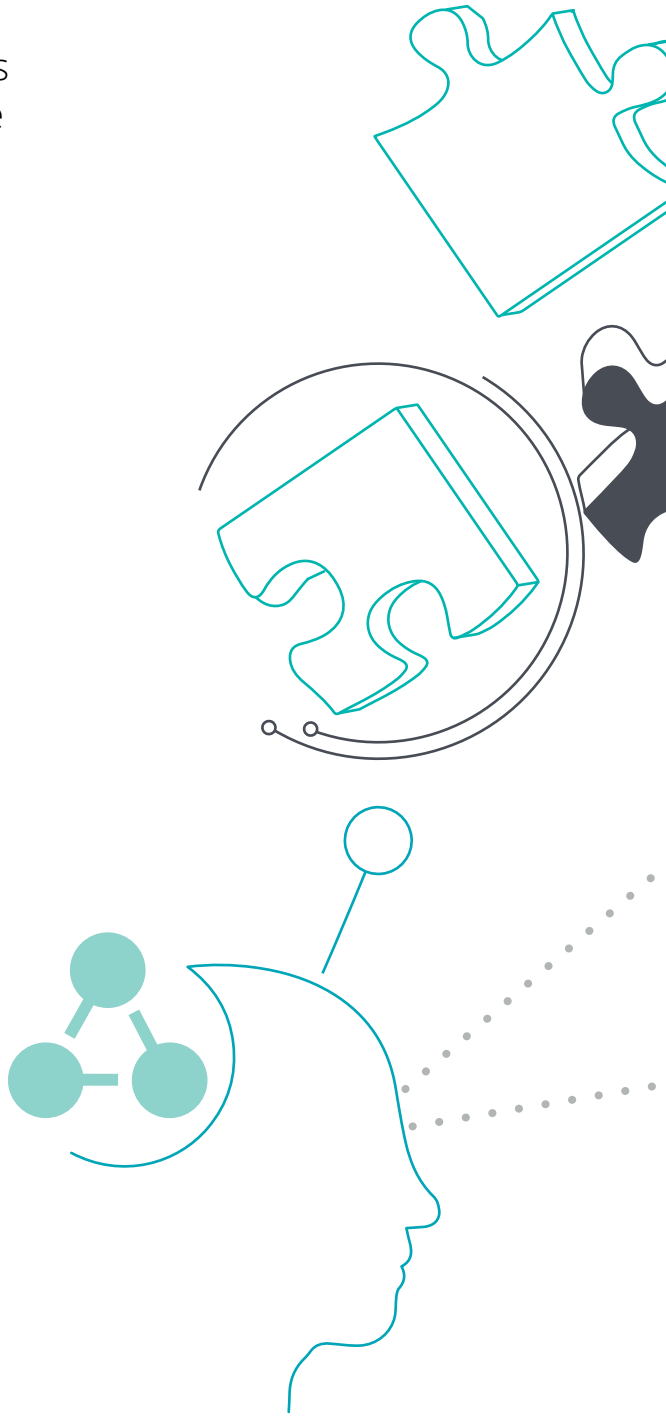
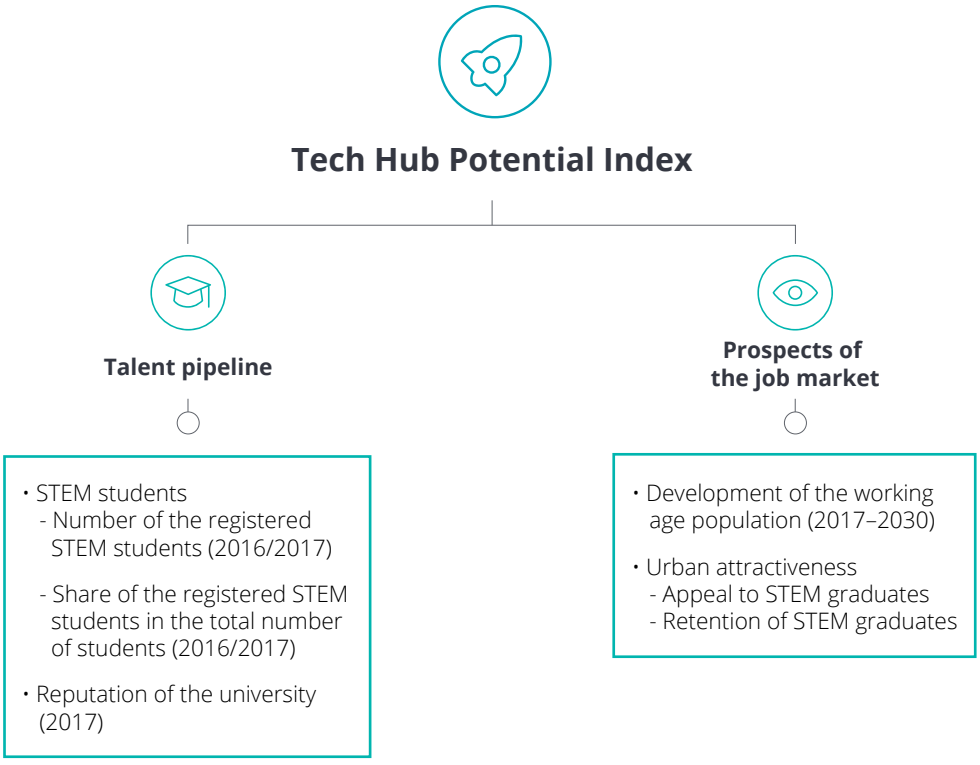


Fig. 8 – Tech Hub Potential Index



Overall, Munich is also leading in the potential index. This is primarily due to Munich having a great appeal to the next generation of tech talents and the highest reputation of all technical universities in Germany. In addition, Munich is one of two cities among the 50 German metropolitan regions for which a growing employment figure until 2030 is forecasted.

Due to its outstanding position in the talent pipeline, Darmstadt ranks second. Moreover, Darmstadt also offers goods job market prospect. Besides Darmstadt, other smaller tech hubs like Aachen or Karlsruhe score well in the talent pipeline. Berlin benefits from its high number of STEM students and a high university reputation; Hamburg benefits from a high appeal to tech talents.

Munich and Berlin lead both in terms of the number and growth of STEM jobs. The highest degree of specialization among STEM jobs, however, is found in Erlangen

Tab. 4 – Results of Tech Hub Potential Index – Ranking of the Top 30-Cities

Rank	City	Score	Talent pipeline Rank	Job market Rank
1	**Munich**	**94**	**4**	**1**
2	**Darmstadt**	**90**	**2**	**4**
3	**Berlin**	**86**	**5**	**5**
4	**Hamburg**	**83**	**12**	**2**
5	**Stuttgart**	**81**	**7**	**8**
6	**Aachen**	**76**	**1**	**23**
7	**Karlsruhe**	**75**	**3**	**21**
8	**Dresden**	**74**	**6**	**13**
9	**Erlangen**	**73**	**19**	**3**
10	**Frankfurt am Main**	**72**	**16**	**6**
11	Hannover	69	8	20
12	Heidelberg	66	23	7
13	Münster	65	18	10
14	Bonn	59	14	24
15	Leipzig	59	38	9
16	Bremen	57	10	30
17	Regensburg	56	26	14
18	Düsseldorf	56	22	17
19	Ulm	55	15	27
20	Cologne	54	27	15
21	Nuremberg	54	37	11
22	Freiburg im Breisgau	54	36	12
23	Kiel	52	21	26
24	Mainz	49	27	25
25	Dortmund	49	9	40
26	Paderborn	49	39	16
27	Kaiserslautern	48	11	39
28	Augsburg	48	40	18
29	Konstanz	47	42	19
30	Braunschweig	46	17	33

Talent pipeline

The city with the absolute highest number of STEM students is Berlin. 77,000 students have been registered in the STEM subjects in the German capital. Following at some distance behind is Munich (53,000 students) and then Darmstadt (36,000 students). Stuttgart, Dortmund and Hamburg are behind. With its 29,000 STEM students, Karlsruhe follows as a further smaller tech hub.

In addition to the absolute number of STEM students, two other factors are important: The specialization of the universities in STEM subjects, measured as the share of STEM students in the total number of students, and the strength of the reputation enjoyed by the local universities.

The specialization in STEM subjects is the highest with the renowned smaller university cities. In Aachen, more than three quarters of the students have been registered in STEM subjects, and this share is only marginally lower in Darmstadt (74 %), Braunschweig (73 %) and Karlsruhe (69 %). At the universities in the large cities, the STEM share is the highest in Stuttgart (49 %) and in Munich (41 %).

Regarding the reputation enjoyed by the German technical universities, the renowned names are at the top. The Munich universities enjoy the overall highest reputation, followed by the Berlin universities, Aachen, Karlsruhe and Darmstadt[6]. A detailed look at the individual STEM subject reveals that Munich enjoys the highest reputation in mathematics, informatics and technology, while Hannover is leading in the field of natural sciences. Berlin, Aachen and Darmstadt mainly score in the technology sector, while Bonn and Heidelberg take the places 2 and 3 in the reputation enjoyed by the departments of informatics.

Workforce

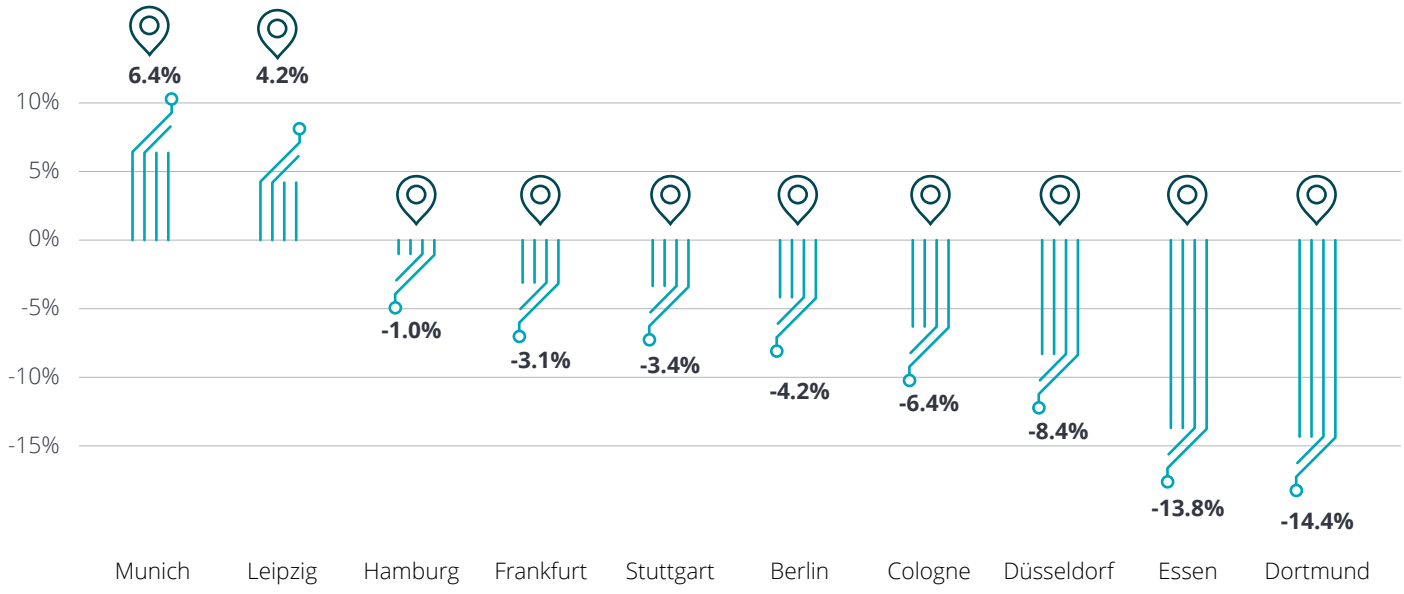
The prospects of the job markets in the large German cities are difficult to predict in detail. However, there is a component that can be predicted relatively well: the demographic trend in the workforce. The future size of the workforce in a city is crucial for the city's general talent pool and for the potential dynamics of the job markets.

However, due to the demographic trend in Germany, nearly all cities will face a decrease in the workforce, although to a differing extent. The only two exceptions among the 50 German metropolitan regions are Munich and Leipzig. According to the forecast, the Bavarian capital can expect an increase in the workforce by 6 % by 2030.

Hamburg, Dresden and Frankfurt are expected to see a slight decrease in the workforce between 1 % and 3 %. This decrease is expected to be larger in Berlin and Karlsruhe (more than 4 %), while Düsseldorf might lose 8 % of its workforce.

[6] The ranking includes universities throughout the entire metropolitan area.

Fig. 9 – Change in the working population in the 10 largest German cities, 2017-2030 (in %)



Source: Oxford Economics

Appeal to tech talents

The next generation of the German tech talents, i.e. today's STEM-students, continues to head for the large cities. A Deloitte Survey among about 900 German STEM students reveals that Hamburg is seen as the most appealing German city for a career start (see Fig. 12) by 34 % of the respondents. Very closely behind are Munich (33 %) and Berlin (26 %). The top 7 cities include Frankfurt, Cologne, Stuttgart and Düsseldorf on the further places.

However, key factors for the cities are both the attractiveness as a later tech location and the preference of students for remaining in the city where they are currently studying after completion of their studies. Münster ranks first in this category; nearly all surveyed STEM students would prefer to remain in Münster after completion of their studies. Münster is followed by Munich, Hamburg and Berlin. In Hannover, Kiel, Düsseldorf and Frankfurt many of the local STEM students also intend to work there later on.

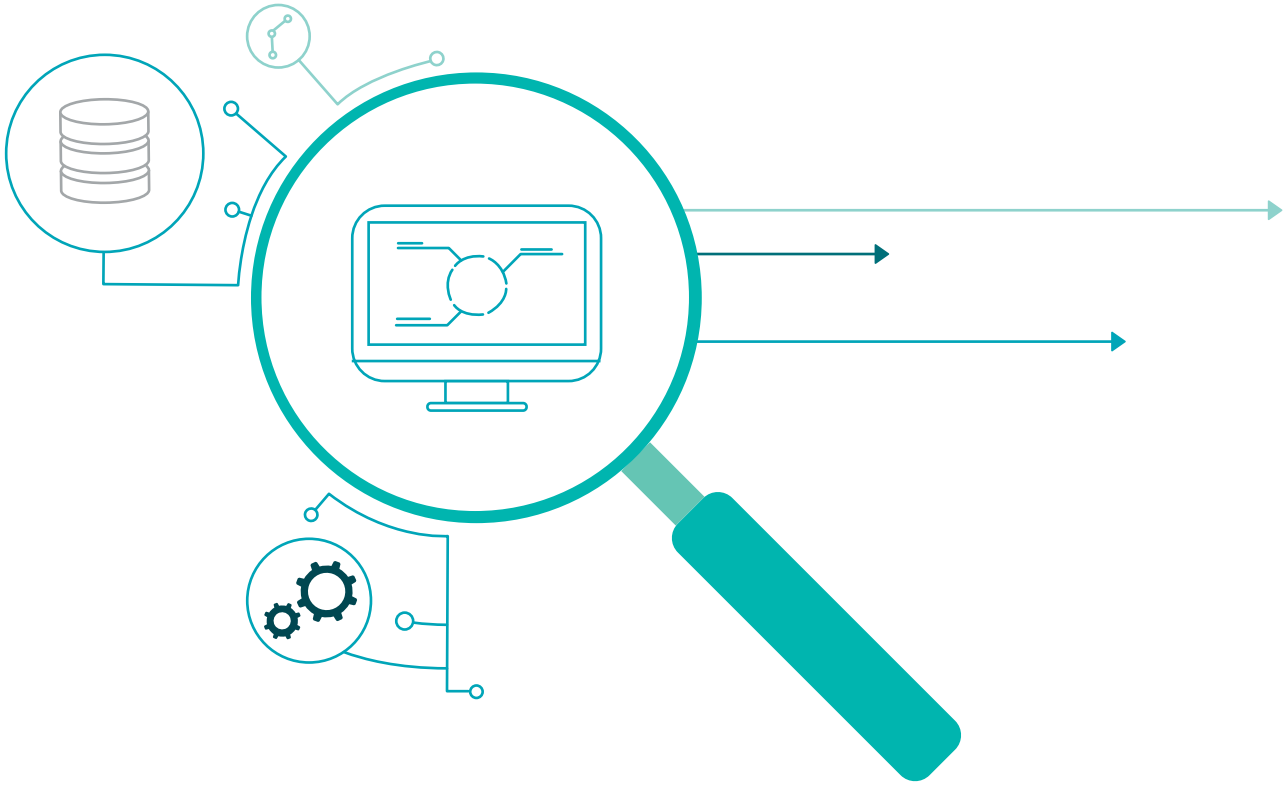
The general trend with the German STEM students is their preference of remaining and working at the current place of their studies. Three quarters are planning to do so. As far as moves within Germany are concerned, the students are regionally rooted. Many students say that they prefer to move to the nearest metropolis. For example, STEM students from Kiel prefer to move to Hamburg, students from Ulm and Nuremberg to Munich, and graduates from Darmstadt and Bonn to Frankfurt or Cologne.

Despite their rather regional roots within Germany, German STEM students are certainly also internationally oriented, if they are offered the opportunity to work abroad. Nearly two third are basically willing to work outside of Germany, with the favorite places being the Anglo-Saxon countries and Switzerland. Regarding foreign cities, London leads the lists of the cities most appealing to STEM talents, followed by New York, Stockholm, Los Angeles and Sydney.

Tab. 5 – Appeal to STEM students

Rank	City	(%)
1	**Hamburg**	**34%**
2	**Munich**	**33%**
3	**Berlin**	**26%**
4	Frankfurt am Main	25%
5	Cologne	22%
6	Stuttgart	19%
7	Düsseldorf	14%
8	Leipzig	11%
9	Hannover	9%
10	Münster	8%

Source: Deloitte STEM-Talent Monitor 2018



Across Germany, Hamburg, Munich and Berlin are most attractive to STEM talents. In the international context, particularly STEM graduates can imagine a career start in metropolitan regions in the English-speaking countries such as UK, Australia and the U.S.A.

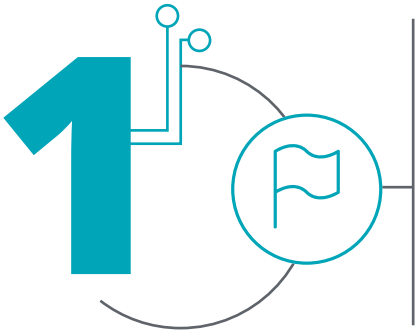
Implications and Outlook

There is a clear overall trend in respect of the digital hubs in Germany. The economic effects of the digital transformation are not spread evenly across cities and regions. Cities that have reached a critical mass are becoming increasingly attractive and are developing a magnetic effect on digital talents. In Germany, two digital hubs are predominant: Munich and, at some distance, Berlin. Both cities are magnets for the ICT industry, and Munich in addition for digital talents in the traditional economic sectors.

In addition, there are some smaller leading tech hubs – Erlangen, Darmstadt, Karlsruhe – which due to their position in local education facilities or the local tech industry represent relevant locations. This concentration on just a few locations is economically significant for the future, as the added value generated by the digital industry and the digital jobs is likely to even continue to increase from today's high level.

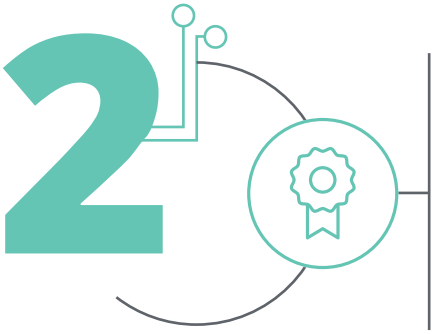
The trend towards concentration of the digital economy and of digital talents does not only take place at national level, but also at international level. Therefore, competition between locations is likely to take place in the future to a smaller extent between local hubs, but to a larger extent between international tech hubs, whereby Munich and Berlin in the future will especially compete with innovation regions like the Silicon Valley, Tel Aviv or Stockholm.

The consequences are three implications for policy making and enterprises:

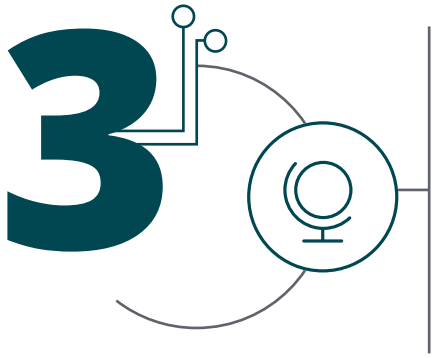


German cities need to ensure that they appeal to international tech talents and investors, and participate in designing international innovation ecosystems. Digital hubs are increasingly specializing in specific segments or technologies. Berlin, for example, seems to be aligned in the digital sector rather to the end customer segment, whereas Munich rather to the B2B segment.

Innovation regions are also specializing at international level. Shenzhen has a focus on robotics, whereas Taiwan is developing a center for the "Internet of Things" in Taoyuan. Building bridges to other digital hubs and thereby building innovation networks is likely to become crucial for locations and enterprises because of the global character of digital innovation.



The regional dimension of the locational advantages in the digital economy is becoming increasingly important. This means that regions and cities need to find the special niches in the digital economy in which existing strengths in traditional sectors are most relevant. At the political level, the funding of R&D is an important starting point and lever to this end. For cities, the issue is not merely to attract companies, but also talents. The "creative class" is mobile and is attracted by urban life and a high standard of living. Cities that offer this standard in combination with first-class research and education, have a good chance to develop innovation clusters.



For companies, the internationalization of innovation means that they need to be represented at the right innovation location in their sector or their segment – both nationally and internationally. Innovation in ecosystems also means that the companies need to integrate in these systems at any early stage, either through co-operations or through on-site presence. The establishment of innovation departments of German companies in the Silicon Valley is a step in that direction, which needs to finally result in a network enabling to exploit the different strengths of the tech hubs. This strategy must also regard the strengths of the German tech hubs, including those of the hidden champions.

Previous Publications in the Series of Studies “Data Nation Germany“

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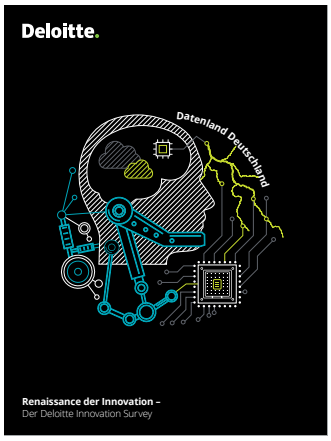
(April 2018)

Data Nation Germany - Expectations and Attitudes of German STEM Students



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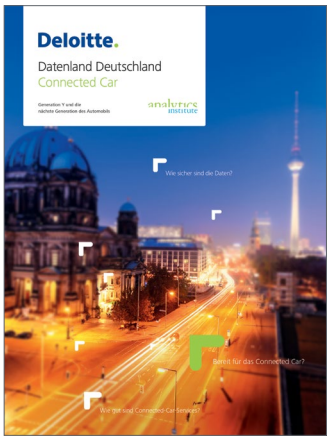

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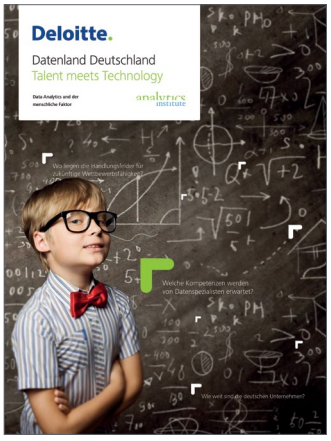

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