Impacts of digitization on real estate sector jobs
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Abstract
Purpose – Previous research on automation and job disruption is only marginally related to the real estate industry and its characteristics. This study investigates the effects of digitization on jobs in German real estate sector, in order to assess the proportion of jobs threatened to be replaced by automation. Since Germany is the largest EU economy insights for the German real estate market allow a first approximation for Europe.
Design/methodology/approach – An extensive database of the German Federal Employment Agency containing job definitions and occupation titles is matched with real estate criteria to create a subset with the relevant real estate occupations. This data is combined with a database of the German Institute of Employment Research reflecting to what extent tasks within jobs can be automated by current technical capabilities.
Findings – For the 286 identified occupations within the real estate sector a weighted average of 47 percent substitution probability through current technological capabilities is derived for tasks within the examined occupations.
Practical implications – This contribution indicates the extent of the structural change the real estate sector has to face due to digitization: One out of two real estate jobs will have to be re-created.
Originality/value – This research quantifies the magnitude of the job killer aspect of digitization in the real estate sector.

Keywords Employment, Digitization, Automation, Structural change, Disruption, Substitution potential

Paper type Research paper

1. The challenge for jobs
When the popular media routinely run article titles like “A World Without Work” (Thompson, 2015), there is a strong indication that an issue has reached a significant level of critical mass. There is no disputing that new technologies (NT) are disrupters to labor and vocational categories, however, the levels of disruption and its impact are not agreed on. At the same time, the utilization of NT’s leads to new possibilities and job areas that are being created. These jobs differ in their complexity and demands, and therefore are often better paid.

Innovation and its impact on labor is part of structural change. Pessimistic views in the last year are frequently based on insights from Frey and Osborne (2013) who quantified the impacts of NT’s on labor markets in the United States. Accordingly, 47 percent of jobs are subject of being substituted by NT’s until 2030. Various studies have used the results of Frey and Osborne by transferring the codes of American occupations to other countries (Bonin et al., 2015; Dengler and Matthes, 2015; Brzeski and Burk, 2015), according to the International Standard Classification of Occupations (ISCO). However, these studies follow the approach that it is not entire professions that can be replaced by NT’s, but rather activities leading to a significantly lower share of jobs that are being threatened to be substituted by computers. Arntz et al. (2017) maintain that there is evidence to support an impact of a 9 percent to 11 percent job loss in OECD countries caused by digitization. For the purpose of serving as a literature review to a wider study that specifically aims at the impact of NT’s on real estate,

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the focus of the following will ask whether there is anything emergent about the current transformations and a long history of previous disruptive phases.

Wage stagnation has been an important economic force that has occurred steadily since the 1980’s among Organization for Economic Co-operation and Development (OECD) nations. Stagnation means that wages are relatively flat and do not rise at the rate of inflation. Among these OECD countries, this is a reversal of economic trends that have defined most of the Twentieth Century and was accelerated in particular, during the post-World War Two period. It is a period where the most prominent factor of this trend is that each subsequent generation had more wealth and disposable income than the previous. The consequence of this stagnation is that little growth is occurring and lower relative wages means that capital is not circulating in the economy given that people simply have less disposable income to spend (Picketty, 2014). The economy has stagnated, but capital or profit has increased and this is explained through fewer workers creating more profit and also, a shift toward the financialization of the economy. At the same time, Gregory et al. (2016) conclude that from 2000 to 2010 there has been a steady increase in labor demand. In spite of this shift on the other hand, rising unemployment has not been an outcome through the processes of automation that have occurred so far (Arntz et al., 2017). Within the context of Artificial Intelligence (AI), Machine Learning (ML) and robotics, these general factors raise a number of important variables for consideration because they make the impact of these new technologies difficult to measure.

When the data concerning wage stagnation is combined with the analysis of large sets of tax returns in the US and France over a fifty-year period (Picketty, 2014), a number of competing theories emerged as plausible explanation for this. One theory was that through the erosion of the bargaining power of labor wages have stagnated. A second major theory was that outsourcing of tasks and globalization of production are the most significant drivers of stagnation. Manufacturing and then service sector jobs have continually been moved from developed economies to emerging economies because of lower standards for regulation (Addo, 2016). After a period of stagnation being explained by theories about bargaining power shifts and globalization, a new set of evidence began to present NT’s as the most important driver to this trend. However, the wider use of NT has various, mutually conflicting consequences. Variables of influence like globalization and political policies, cannot be completely separated from NT’s as a factor for job loss and the de-skilling of labor which has resulted in lower wage forms of employment. Frey and Osborne (2017) assert that this creates a greater “polarization” between skilled and unskilled labor and therefore “a hollowing-out of middle-income jobs”.

The following will examine the level of disruption on the real estate sector in particular. There is an important and conflicting set of assumptions and conclusions that make this difficult to determine. For reasons that will be outlined in the Literature Review, this study will take the task-based approach to automation or substitution potential defined by Dengler and Matthes, 2015, 2016 in order to determine the share of jobs in the German real estate industry that are affected by digitization. The article concludes with a discussion on the remaining tasks for human beings in the real estate industry.

2. Literature review
NT’s can be understood as having a long history within the capitalist economy. The mechanization of labor can be traced to the steam powered machines that replaced hand weaving in the clothing industry in the late 1700’s and early 1800’s. This economic transformation to industrialization also contributed to an early reactionary backlash, which led to protests by workers in England between 1811 and 1816 when these new machines were blamed for unemployment and low wages. Consequently, the manufacturing equipment was damaged by workers (DeCanio, 2016; Frey and Osborne, 2017). Industrialization and
automation were furthered when the Ford model of production was invented and then, quickly adopted by other types of industries. Henry Ford introduced the assembly line model of production whereby individuals become specialized in only one area of manufacturing and this division of labor made production more streamlined and created greater output. The automation of tasks and the deskilling of labor are not new. Likewise, neither is the criticism of automation that has historically been based on the loss of employment and the de-skilling of existing work tasks. However, the counterweight to this trend has been the economic gains that have emerged as a result. Various areas of employment have been created by the technological change that has led to an expansion of entire sectors such as electronics and computer related fields. For example, Bessen (2016) presented a comprehensive data set of 317 types of jobs that were being replaced by automated technologies driven by computerization and demonstrated that newly created types of employment far exceeded the losses caused by automation. Based on the structure of industrialization within a historical context, DeCanio (2016) presents a data analysis of tasks and substitution potential, and concludes that wage levels will decrease, and that although NT’s create new opportunities in fields like engineering, the overall outcome will be the de-skilling of labor.

There are a number of criticisms to this historically driven approach to job market changes. An important criticism of is related to market capitalization and value creation. West (2018) looks at the relationship between market capitalization and employment and compares data taken from 1962 to 2017. In 1962 the two largest companies in terms of market value were AT&T with a value of USD$ 20B (2017) with 564,000 employees and General Motors with a USD$ 12B (2017) value and 605,000. In 2017, Apple had a market capital share of USD$ 800B with 116,000 employees and Google/Alphabet had USD$ 670B and 73,992 workers. In other terms, Apple generated forty times the wealth as AT&T with a fifth of the full-time employees (West, 2018). As a good example of this wealth generation process achieved by few, two individuals developed Android with less than $ 10,000 and then sold this in less than a year to Google for a $ 1B and at the point of sale they employed 50 individuals (Madridakis, 2017). While some maintain that more jobs have been created by the overall computerization (Bessen, 2016), there are important features in current technologies that have to be considered for future projections. Although in the past there was a link between employment growth and innovation, in the future other factors specific to new technologies might generate value without employment growth.

AI can be seen as an example of different value creation in the context of social media and the platform economy. In 2017, Facebook had a market value of USD$ 441B with 18,770 employees (West, 2018). The Facebook revenue was generated through the use of clients’ data for the purposes of generating advertising, marketing and market research, and the means for this was the AI employed in data mining/collection and data-analytics. Platform models are achieving the same by having algorithms and not humans connect customers with service providers and then, collecting a fee through this human-less transaction. Facebook’s market value to employee ratio is significantly greater than either Apple or Google.

Within the real estate industry, the platform economy and the use algorithms is likewise growing. Conway (2018) identifies nine major industry areas where 71 software applications and web-based platforms are emerging that replace human tasks and occupations. A number of these real estate areas include data analytics and platform applications that connect buyers and sellers, borrowers and lenders, customers and legal documents, customers and valuations. These areas are data driven AI applications, thus algorithms rather than people generate value.

Other areas are using more NT’s and change the tasks performed by the human employees. The fastest growing area is buildings and operations management where remote security systems, smart home technologies and robotics used in cleaning and maintenance are already having a significant impact. Further, new possibilities emerge through 3D...
technologies employed in viewing properties and through 3D printing. Thus an image can be quickly generated into an entire model of a building or a neighborhood area. Companies like Doxel, OpenSpace, and Airworks specialize in digital photo-capturing buildings and construction sites by having cameras that are fixed, mounted on robots, on drones and construction worker hats (Conway, 2018). Conway identifies how NT’s including AI, machine learning and big data create opportunities in the real estate sector because of their positive results in data-gathering, distribution, and analytics, automated valuation models, risk assessment, communications, and business processes. Furthermore, that are additional emergent areas such as Augmentation and Space Planning, Geospatial Analytics, and the internet of Things (IoT). Augmentation and Space Planning is the use of video capturing to create accurate 3D-ready spatial/building information. Geospatial Analytics includes how this data is processed into 3D-models, drawings, or animated formats. Conway (2018) defines this emerging real estate processes in the following terms: “Geospatial analysis is the gathering, display, and manipulation of imagery, GPS, satellite photography and historical data, described explicitly in terms of geographic coordinates or implicitly, in terms of a street address, postal code, or forest stand identifier as they are applied to geographic models” (Conway, 2018, p. 47).

Deloitte (2018) shows that the real estate service of the future must move away from the pure operational management of the buildings to a holistic approach that ensures that the customers are able to function.

Where some tasks such as a telephone dispatcher who would have conventionally connected a taxi driver with a customer have been replaced by the AI contained in phone apps, other tasks such as building maintenance, construction, and manufacturing will continue to require human participation. All of these areas are significant to the real estate business in particular. These discrepancies in drivers of automation versus job growth, significantly impact the theories that underpin future predictions in employment (Arntz, 2017; DeCanio, 2016). By contrast, the literature as a whole identifies variables such as hand precision and human to human contact as areas that will continue to be decisive for human employment. These tasks cover front line health care and surgery, hair cutting, cultural production and the arts. Furthermore, areas with soft skills like creative and social intelligence will be the types of non-routine tasks that cannot be replaced (Frey and Osborne, 2017).

There are a number of considerations regarding automation and gender. Dengler and Matthes (2015) demonstrate that male dominated vocations will be significantly more impacted than conventionally female jobs; however, it does not follow that the demand will increase for women because of this shift given that gender roles have determined both career choices, but also the social value placed on certain areas of work. A study of PricewaterhouseCoopers LLP (PricewaterhouseCoopers LLP, 2017) reveals similar findings, stating that female workers could be more affected by automation in the short term, but male jobs are more at risk of being automated in the long term. Males have dominated areas like manufacturing and facility related production occupations, and these are among the highest in terms of substitution potential (Dengler and Matthes, 2015). There is a limitation of looking at the change in supply and demand terms, given that there are considerations about how value is determined, and where women’s work has been subject to the devaluing caused by patriarchy. This raises the important issue about how a job is evaluated and how consistent the automation design systems are when they are broken down into specific tasks (Arntz et al., 2016).

In the existing literature, there is a wide range of the effects of NT on employment numbers. At the high end of the predicted numbers are studies like Bowles (2014) who predict a loss of 60 percent of jobs due to NT and the Frey and Osborne study (Frey and Osborne, 2013, 2017), cited over 3,500 times, that predicts that by 2030 47 percent of analyzed 730
occupations will disappear through automation. By contrast, on the low end of the scale, 
Arntz et al. (2017) take a different approach by measuring automated tasks against full occupations, predict that only 9 percent to 11 percent of all jobs in OECD countries will be lost. To demonstrate the importance of tasks as opposed to isolating the automation of whole occupations, Arntz et al. (2017) use the data for the Frey and Osborne (2013) study that concluded that 47 percent of all jobs will be lost and reduced it to 9 percent by isolating the tasks within the jobs rather than the jobs themselves. The occupations defined by the substitution potential based on five tasks that include: manual non-routine tasks, interactive non-routine tasks, manual routine tasks, cognitive routine tasks and analytical non-routine task (Dengler and Matthes, 2015). Another international comparison is carried out by Nedelkoska and Quintini (2018). According to this, 14 percent of all jobs in OECD countries can be highly automated. For all 32 OECD countries analyzed in the study, this means 66 million jobs. Looking at the automation potential from 50 to 70 percent, it is even 32 percent of all jobs. This shows that structural changes are to be expected in large areas of the world of work as a result of digitization.

A study of the McKinsey Global Institute (McKinsey Global Institute, 2017) emphasizes on the job creation aspect of digitization. While NT’s do replace jobs, they are creating new work possibilities. Accordingly, one-third of the newly emerged jobs of the past 25 years in the United States are directly linked to NT’s, i.e. IT management and app creation. The study further underlines the importance of NT’s on economies and their productivity.

The literature review presented has emphasized that the cross relational data and structural elements that has be used to describe the general trends within employment and automation can be applied to the real estate industry. What is unique to real estate, are the sub specialty areas like an emerging online and platform-based services that are already disrupting the real estate business as it has been conventionally run.

3. Methodology and results
Previous research has shown that it is not entire professions that can be automated, but rather tasks within occupations. In the following, the substitutability potential of occupations within the real estate industry in Germany is examined. The substitutability potential of an occupation is defined via the proportion of routine activities, which are likely to be automated by current technological capabilities (Dengler and Matthes, 2015).

When assessing the level of substitutability potential, the categorization suggested by Frey and Osborne (2013) is used: A low substitutability potential exists if a maximum of 30 percent of activities within an occupation can be performed by computers. An average substitutability potential means that between 30 percent and a maximum of 70 percent of activities are automatable. A high substitutability potential means that more than 70 percent of activities could be replaced by digitization.

The methodology applied in this contribution is set out in Figure 1.

In contrast to the previous studies on the impacts of automation on jobs, the substitution probabilities are not determined on the basis of American occupation data, but rather information on occupational research from the expert database BERUFENET (Bundesagentur für Arbeit, 2019), which provides information on all occupations known in Germany online and free of charge. The BERUFENET is used for job placement and information and contains approximately 3,900 occupations. The information provided includes information on the respective professional activities, necessary training or legal regulations.

Dengler and Matthes (2015) originally determined the task composition for each occupation on the basis of this database. For this purpose, the authors created a requirements matrix, in which approximately 8,000 requirements are assigned to the respective occupations. When deciding whether a work requirement should be understood as a routine or non-routine activity, it was explicitly researched whether the respective activity could be carried out by
computer-controlled machines. Replicability by computers or computer-controlled machines was therefore a central criterion in deciding whether a requirement was categorized as a routine or non-routine activity. Therefore, the proportion of routine activities represent as a measure of the substitutability of these professions. Dengler and Matthes (2015) utilized the requirements matrix and calculated the proportion of routine activities (vs. non-routine activities) by dividing the core requirements in each individual occupation. These shares at individual occupational level are aggregated for the various occupational aggregates with a weight calculated on the basis of the number of employees in 2016.

The requirements matrix is not publicly accessible, however, Dengler and Matthes created the database IAB-Job-Futuromat (Institute of Employment Research, 2019) for the public in order to access the calculated automation probabilities for each occupation. The IAB-Job-Futuromat is a database that contains the occupation-specific substitution potentials along with job specific individual substitution potentials. Furthermore, the IAB-Job-Futuromat provides the substitution potentials for each of the 286 occupations taken from the second data set used in this study. The second data set is the BERUFENET database (Bundesagentur für Arbeit, 2019) which provides occupational titles from which 286 real estate sector occupation titles have been manually collected. These real estate titles have been categorized according to the classification of real estate industry job fields provided by Just et al. (2017). It is important to note that real estate can be either defined in a narrow sense or in a broad sense. The real estate sector within a narrow sense consists of the areas 1) real estate trade, 2) renting and leasing and 3) mediation and administration. However, far more activities are frequently also seen as an essential part of the real estate sector. Consequently, Just et al. (2017) add additional areas to the real estate sector in a broad sense: 4) architectural/engineering offices, 5) construction industry (building construction/civil engineering), 6) real estate financers, 7) investment companies, 8) industrial cleaning and 9) other service providers. Some people argue that the planning of building should be seen as an integral aspect of real estate and thus, Architectural/engineering offices should be part of the real estate sector in a narrow sense. Other people might see the construction industry (building construction/civil engineering) as a core aspect of real estate, since the building of

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**Figure 1.** Methodology for the calculations of the automation probabilities

**Source(s):** Own representation
the properties is the most decisive aspect of the changing urban landscape. The decisive aspects of development and equity investment for the real estate sector are covered through the category investment companies. Consequently, we use the broad sense of the real estate sector for the categorization of real estate industry job fields to be able to examine the impacts of digitization on real estate sector jobs.

In the next step the IAB-Job-Futuromat database (Institute of Employment Research, 2019) was used to assign a substitutability probability to each occupation title (KldB 2010 5-digit level). Based on the approach by Dengler and Matthes (2015) each substitutability potential was mapped to the respective occupation title. For example, the job-profile of a facility manager contains the following essential activities. Therefore, the substitution probability of a facility manager is 60 percent (Table I).

These substitution probabilities at individual occupational level are aggregated for the various occupational groups with a weight calculated on the basis of the number of employees in 2018.

This requires a weighted average calculation of the substitutability potential and the respective employee count subject to social insurance. However, the employee count data is only available at occupational group level. In order to map the broadest possible occupational spectrum on the one hand, but on the other remain clear to a certain extent, the employee counts within an occupational group is assumed to be equally distributed following the approach by Dengler and Matthes (2015), which enables to calculate a weight based on the average substitutability of occupation titles within an occupational group and the employee count of the occupational group. Based on this approach the 286 occupation titles within 164 occupational groups have been aggregated covering a total of 5,231,766 employees subject to social insurance within the real estate industry (as set out in Table II). For these 5,231,766 employees within the real estate industry the weighted substitutability potential comes to 47.41 percent. This means that almost a half of all jobs in the real estate sector tasks can be automated by current technical capabilities.

A further insight can be gained by looking at the consolidated automation potential (Table III).

In analogy to Dengler and Matthes (2018), the automation potentials are classified as high (> 70 percent), medium (50 percent to 70 percent) and low (< 30 percent). This categorization that almost 36 percent of all jobs within the real estate sector have a high automation potential. Approximately 15 percent of the occupations have a medium automation potential. Overall, the analysis shows that approximately half of all the jobs within the real estate industry have an automation potential that exceeds 50 percent.

| Activity                                                                 | Can be performed by computers, robots or artificial intelligence |
|--------------------------------------------------------------------------|---------------------------------------------------------------|
| 1  Maintenance management                                                 | ✗                                                              |
| 2  Building system technology, building control technology                | ✓                                                              |
| 3  Building services                                                      | ✗                                                              |
| 4  Invitation to tender, award of contract, description of services       | ✓                                                              |
| 5  Facility management (coordination)                                     | ✗                                                              |
| 6  Real estate business management                                        | ✗                                                              |
| 7  Property management                                                    | ✓                                                              |
| 8  Cost and activity accounting                                           | ✓                                                              |
| 9  Calculation                                                           | ✓                                                              |
| 10 Apply Facility Management Software (CAFM)                              | ✓                                                              |

**Table I.** Example job profile and substitution potential for the occupation facility manager.

Source(s): (Institute of Employment Research, 2019), Dengler and Matthes (2015), own representation.
4. Conclusion

The digital transformation of the real estate sector is lagging behind other sectors. However, the real estate industry is facing seismic change. The adaption of technologies such as data analytics, artificial intelligence, machine learning and robotics are transforming operations. Highly administrative, humanly performed tasks are becoming increasingly redundant. Although the disruption is significant, the industry has a number of limitations that make the complete automation of this sector difficult or impossible to completely make. By contrast, there are notable intersections of negative trends that are also a consideration and that is the deskilling of labor and the greater polarization between highly skilled or professional credentials and employment that can be achieved by anyone. When work can be done by the lowest common denominator, the over abundant supply means that the wages can remain

| Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|----------------|----------------------------------------------------------|
| 1 Skilled workers in commercial and technical business administration (without specialisation) | Aufsichtskräfte im Aus- und Trockenbau, Isolierung, Zimmerei, Glaserei, Rollladen- und Jalousiebau | 936,387 | 44.00% |
| 2 Specialists in building services engineering (without specialisation) | Fachkräfte in der Gebäudetechnik (ohne Spezialisierung) | 233,272 | 66.00% |
| 3 Specialists in construction electrics | Fachkräfte in der Bauelektrik | 224,334 | 75.00% |
| 4 Specialists in metal construction | Fachkräfte im Metallbau | 216,635 | 85.00% |
| 5 Specialists in sanitary, heating and air-conditioning technology | Fachkräfte in der Sanitär-, Heizungs- und Klimatechnik | 171,535 | 70.00% |
| 6 Specialists in woodworking, furniture and interior design | Fachkräfte im Holz-, Möbel- und Innenausbau | 142,619 | 55.75% |
| 7 Specialists in information and telecommunications technology | Fachkräfte in der Informations- und Telekommunikationstechnik | 141,812 | 94.33% |
| 8 Specialists in electrical operating technology | Fachkräfte in der elektrischen Betriebstechnik | 116,174 | 70.00% |
| 9 Specialists for painting and varnishing work | Fachkräfte für Maler- und Lackierarbeiten | 113,616 | 30.25% |
| 10 Technical draughtsmen and women | Technische Zeichner/innen | 111,285 | 78.25% |

Source(s): Appendix Table A1

Table II.
Automation Probability of the ten largest occupation groups

| Table III. Summarized automation probabilities of jobs in the real estate sector |
|--------------------------------|--------------------------------|----------------|----------------------------------------------------------|
| Probability of Automation of over 70% | 1,883,724 | 36.01% |
| Probability of Automation between 50 and 70% | 783,423 | 14.97% |
| Sum: Probability of Automation of over 50% | 2,667,147 | 50.98% |

Source(s): Bundesagentur für Arbeit (Bundesagentur für Arbeit, 2019a), Bundesagentur für Arbeit (Bundesagentur für Arbeit, 2019b), Institute of Employment Research (Institute of Employment Research, 2019); own calculations
low. The problem with low wages is two-fold in terms of stagnation, and it means that lower incomes mean that less money is circulating in the economy, and that has a secondary effect of reducing any capacity for reinvestment and then growth. The circular effect on real estate and the economy in general, is punctuated by a smaller pool of consumers for property and a lower overall price as well. The deskilling and polarizing of labor along with the economic stagnation that this causes, is countered by the benefits such as the creation of new industries and work opportunities. Further, there are a number of factors that will contribute to a lag for adopting NT’s and the driverless car is a good example where the existing technology is available, but the legislative framework and social acceptance of lags behind. These social and political considerations are significant to the growth of automation and at the same time, they are difficult to predict and therefore create limitations on any model that assesses the risk to employment. Both the obstacles to a quick transformation and job creations thanks to the new possibilities of NT’s highlight the necessary aspects that also have to be considered in the interpretation of the 47 percent figure of disappear jobs within the real estate industry.

Further, an occupational approach that looks at macroeconomic trends along with standard data collected from current employment data can only represent a snapshot of a static scenario analysis. This contribution has emphasized that a task-based approach demonstrates how high the percentage is of jobs affected: Almost every second job within the real estate industry. However, also in the real estate industry new jobs will be generated thanks due to NT. For example, in data analytics and photo capturing technologies, there has been a significant amount of benefits and growth for the real estate industry (Conway, 2018).

This contribution has focused on the derivation of an approximation for the magnitude of the job killer aspect of digitization. As set out, digitization has also the job motor aspect and many new jobs will arise thanks to digitization. Structural change can be painful for the affected industries, especially if the size of the change required is considerable. Consequently, the real estate industry should be aware of significant shifts and adjustment pains within the sector due to digitization.

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## Table AI.

| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|-------------------------------|--------------------------------|---------------------------------------------------|---------------------------------|--------------------------------|----------------|----------------------------------------------------------|
| 1 Technical manager—roof, wall and sealing technology | Fachleiter/in - Dach-, Wand- und Abdichtungstechnik | 30.00% | Supervisors in dry and dry construction, insulation, carpentry, glazing, roller shutter and blind construction | Aufsichtskräfte im Aus- und Trockenbau, Isolierung, Zimmerei, Glaserei, Rollladen- und Jabusiebau | 8,066 | 28.43% |
| 2 Master glazier | Glasermeister/in | 50.00% | Supervisors in dry and dry construction, insulation, carpentry, glazing, roller shutter and blind construction | Aufsichtskräfte im Aus- und Trockenbau, Isolierung, Zimmerei, Glaserei, Rollladen- und Jabusiebau | 8,066 | 28.43% |
| 3 Industriemeister/in—Acoustic and dry construction | Industriemeister/in - Akustik- und Trockenbau | 20.00% | Supervisors in dry and dry construction, insulation, carpentry, glazing, roller shutter and blind construction | Aufsichtskräfte im Aus- und Trockenbau, Isolierung, Zimmerei, Glaserei, Rollladen- und Jabusiebau | 8,066 | 28.43% |
| 4 Industrial foreman—Insulation | Industriemeister/in—Isolierung | 20.00% | Supervisors in dry and dry construction, insulation, carpentry, glazing, roller shutter and blind construction | Aufsichtskräfte im Aus- und Trockenbau, Isolierung, Zimmerei, Glaserei, Rollladen- und Jabusiebau | 8,066 | 28.43% |
| 5 Master roller shutter and sun protection technician | Rollladen- und Sonnenschutzeotechnikermeister/in | 45.00% | Supervisors in dry and dry construction, insulation, carpentry, glazing, roller shutter and blind construction | Aufsichtskräfte im Aus- und Trockenbau, Isolierung, Zimmerei, Glaserei, Rollladen- und Jabusiebau | 8,066 | 28.43% |
| 6 Master of heat, cold and sound insulation | Wärme-, Kälte- und Schallschutzisolierermeister/in | 17.00% | Supervisors in dry and dry construction, insulation, carpentry, glazing, roller shutter and blind construction | Aufsichtskräfte im Aus- und Trockenbau, Isolierung, Zimmerei, Glaserei, Rollladen- und Jabusiebau | 8,066 | 28.43% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|-------------------------------|--------------------------------|-------------------------------|--------------------------------|----------------|------------------------------------------------------------|
| 7 Work foreman–Finishing      | Werkpolier/in–Ausbau           | Supervisors in dry and dry construction, insulation, carpentry, glazing, roller shutter and blind construction | Aufsichtskräfte im Aus- und Trockenbau, Isolierung, Zimmerei, Glaserei, Rollladen- und Jalousiebau | 8,066 | 28.43% |
| 8 Master roofer               | Dachdeckermeister/in           | Supervisors in building construction | Aufsichtskräfte im Hochbau | 23,343 | 20.83% |
| 9 Scaffolding foreman leader  | Gerüstbau-Kolonnenführer/in    | Supervisors in building construction | Aufsichtskräfte im Hochbau | 23,343 | 20.83% |
| 10 Master scaffold             | Gerüstbauermeister/in          | Supervisors in building construction | Aufsichtskräfte im Hochbau | 23,343 | 20.83% |
| 11 Master bricklayer and concrete builder | Maurer- und Betonbauermeister/in | Supervisors in building construction | Aufsichtskräfte im Hochbau | 23,343 | 20.83% |
| 12 Foreman–Building construction | Polier/in–Hochbau              | Supervisors in building construction | Aufsichtskräfte im Hochbau | 23,343 | 20.83% |
| 13 Plant foreman–Building construction | Werkpolier/in–Hochbau          | Supervisors in building construction | Aufsichtskräfte im Hochbau | 23,343 | 20.83% |
| 14 Master model maker         | Modelbauermaster/in            | Supervisors in technical drawing, construction and model making | Aufsichtskräfte im Technischen Zeichnen, Konstruktion und Modellbau | 2,849 | 69.00% |
| 15 Polisher–Civil engineering | Polier/in–Tiefbau              | Supervisors in civil engineering | Aufsichtskräfte im Tiefbau | 8,817 | 18.00% |
| 16 Master road builder        | Straßenbauermeister/in         | Supervisors in civil engineering | Aufsichtskräfte im Tiefbau | 8,817 | 18.00% |
| 17 Master hydraulic engineer  | Wasserbaumeister/in            | Supervisors in civil engineering | Aufsichtskräfte im Tiefbau | 8,817 | 18.00% |
| 18 Plant foreman–Civil engineering | Werkpolier/in–Tiefbau         | Supervisors in civil engineering | Aufsichtskräfte im Tiefbau | 8,817 | 18.00% |
| 19 Construction machinery foreman | Baumaschinenmeister/in       | Supervisors in construction and transport equipment management | Aufsichtskräfte in der Bau- und Transportgeräteführung | 2,374 | 44.00% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|-------------------------------|--------------------------------|-----------------------------------------------|--------------------------------|--------------------------------|----------------|-------------------------------------------------|
| 20 Master screed layer         | Estrichlegermeister/in         | 29.00%                                        | Supervisors in floor laying    | Aufsichtskräfte in der Bodenverlegung | 875           | 33.00%                                         |
| 21 Master tiler, tiler and mosaic layer | Fliesen-, Platten- und Mosaiklegermeister/in | 30.00%                                        | Supervisors in floor laying    | Aufsichtskräfte in der Bodenverlegung | 875           | 33.00%                                         |
| 22 Master parquet layer        | Parkettlegermeister/in         | 40.00%                                        | Supervisors in floor laying    | Aufsichtskräfte in der Bodenverlegung | 875           | 33.00%                                         |
| 23 Master electrical engineer  | Elektrotechnikermeister/in     | 64.00%                                        | Supervisors in electrical engineering | Aufsichtskräfte in der Elektrotechnik | 15,733        | 73.67%                                         |
| 24 Industrial foreman – Electrical engineering | Industriemeister/in – Elektrotechnik | 80.00%                                        | Supervisors in electrical engineering | Aufsichtskräfte in der Elektrotechnik | 15,733        | 73.67%                                         |
| 25 Master Information Technician | Informationstechnikermeister/in | 77.00%                                        | Supervisors in electrical engineering | Aufsichtskräfte in der Elektrotechnik | 15,733        | 73.67%                                         |
| 26 Industrial foreman – Lacquer | Industriemeister/in – Lack     | 82.00%                                        | Supervisors in point and varnish technology | Aufsichtskräfte in der Farb- und Lacktechnik | 1,288         | 82.00%                                         |
| 27 Industrial foreman – Glass | Industriemeister/in – Glas     | 78.00%                                        | Supervisors in industrial glass production and processing | Aufsichtskräfte in der Industriellen Glasherstellung und -verarbeitung | 310           | 78.00%                                         |
| 28 Industrial foreman – Ceramics | Industriemeister/in – Keramik | 85.00%                                        | Supervisors in industrial ceramics production and processing | Aufsichtskräfte in der Industriellen Keramikherstellung und -verarbeitung | 251           | 85.00%                                         |
| 29 Master ceramist             | Keramikermeister/in            | 64.00%                                        | Supervisors in the arts and crafts of ceramics and glass design | Aufsichtskräfte in der kunsthandwerklichen Keramik- und Glasgestaltung | 127           | 64.00%                                         |
| 30 Industrial foreman – Plastics and rubber | Industriemeister/in – Kunststoff und Kautschuk | 77.00%                                        | Supervisors in plastics and rubber production and processing | Aufsichtskräfte in der Kunststoff-, Kautschukherstellung und -verarbeitung | 1,972         | 77.00%                                         |
| 31 Welding foreman             | Schweißwerkmeister/in          | 75.00%                                        | Supervisors in metal construction and welding technology | Aufsichtskräfte in der Metallbau- und Schweißtechnik | 9,441         | 75.00%                                         |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|-----------------------------------------------|--------------------------------|--------------------------------|----------------|----------------------------------------------------------|
| 32 Master of concrete block and terrazzo manufacturer | Betonstein- und Terrazzoherstellermeister/in | 44.00% | Supervisors in natural stone and mineral processing and processing as well as building material production | Aufsichtskräfte in der Naturstein-, Mineralaufbereitung und -verarbeitung sowie Baustoffherstellung | 1,344 | 59.50% |
| 33 Master of concrete block and terrazzo manufacturer | Betonstein- und Terrazzoherstellermeister/in | 44.00% | Supervisors in natural stone and mineral processing and processing as well as building material production | Aufsichtskräfte in der Naturstein-, Mineralaufbereitung und -verarbeitung sowie Baustoffherstellung | 1,344 | 59.50% |
| 34 Industrial foreman–concrete block industry | Industriemeister/in–Betonsteinindustrie | 50.00% | Supervisors in natural stone and mineral processing and processing as well as building material production | Aufsichtskräfte in der Naturstein-, Mineralaufbereitung und -verarbeitung sowie Baustoffherstellung | 1,344 | 59.50% |
| 35 Industrial foreman–lime/cement | Industriemeister/in–Kalk/Zement | 100.00% | Supervisors in natural stone and mineral processing and processing as well as building material production | Aufsichtskräfte in der Naturstein-, Mineralaufbereitung und -verarbeitung sowie Baustoffherstellung | 1,344 | 59.50% |
| 36 Waste water master | Abwassermeister/in | 50.00% | Supervisors in supply and disposal | Aufsichtskräfte in der Ver- und Entsorgung | 5,832 | 52.40% |
| 37 Master tank and apparatus builder | Behälter- und Apparatebauermeister/in | 63.00% | Supervisors in supply and disposal | Aufsichtskräfte in der Ver- und Entsorgung | 5,832 | 52.40% |
| 38 Master craftsman–recycling and waste management and urban cleaning | Meister/in - Kreislauf- u. Abfallwirtschaft u. Städte reinigung | 22.00% | Supervisors in supply and disposal | Aufsichtskräfte in der Ver- und Entsorgung | 5,832 | 52.40% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|-----------------------------------------------|--------------------------------|--------------------------------|----------------|----------------------------------------------------------|
| 39 Master craftsman–Pipe, sewer and industrial service | Meister/in - Rohr-, Kanal- und Industrieservice | 63.00% | Supervisors in supply and disposal | Aufsichtskräfte in der Ver- und Entsorgung | 5,832 | 52.40% |
| 40 Water master | Wassermeister/in | 64.00% | Supervisors in supply and disposal | Aufsichtskräfte in der Ver- und Entsorgung | 5,832 | 52.40% |
| 41 Domestic operations manager | Hauswirtschaftliche/r Betriebsleiter/in | 50.00% | Supervisors in home economics and consumer consulting | Aufsichtskräfte in Hauswirtschaft und Verbraucherberatung | 11,433 | 58.50% |
| 42 Master craftsman–housekeeping | Meister/in–Hauswirtschaft | 67.00% | Supervisors in home economics and consumer consulting | Aufsichtskräfte in Hauswirtschaft und Verbraucherberatung | 11,433 | 58.50% |
| 43 Master interior decorator | Raumausstattermeister/in | 31.00% | Supervisors in interior design, visual marketing, interior design | Aufsichtskräfte in Innenarchitektur, visuelles Marketing, Raumausstattung | 703 | 31.00% |
| 44 Master installer and heating engineer | Installateur- und Heizungsbauermeister/in | 62.00% | Supervisors in plumbing, sanitary, heating and air-conditioning technology | Aufsichtskräfte in Klempnerei, Sanitär-, Heizungs- und Klimatechnik | 10,843 | 48.50% |
| 45 Master refrigeration system builder | Kältetechnikbauermeister/in | 54.00% | Supervisors in plumbing, sanitary, heating and air-conditioning technology | Aufsichtskräfte in Klempnerei, Sanitär-, Heizungs- und Klimatechnik | 10,843 | 48.50% |
| 46 Master plumber | Klempnermeister/in | 56.00% | Supervisors in plumbing, sanitary, heating and air-conditioning technology | Aufsichtskräfte in Klempnerei, Sanitär-, Heizungs- und Klimatechnik | 10,843 | 48.50% |
| 47 Master builder of kilns and air heaters | Ofen- und Luftheizungsbauermeister/in | 22.00% | Supervisors in plumbing, sanitary, heating and air-conditioning technology | Aufsichtskräfte in Klempnerei, Sanitär-, Heizungs- und Klimatechnik | 10,843 | 48.50% |
| 48 Master painter and varnisher | Maler- und Lackierermeister/in | 36.00% | Supervisors in painting, varnishing, stucco work, building waterproofing, wood and building protection | Aufsichtskräfte in Malerei, Lackiererei, Stuckateurarbeiten, Bauwerksüberdachung, Holz- und Bautenschutz | 6,487 | 32.50% |

Table A1.

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (% | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|-------------------------------|--------------------------------|-----------------------------------------------|-------------------------------|--------------------------------|----------------|----------------------------------------------------------|
| 49 Master craftsman–Timber and building protection trade | Meister/in - Holz- und Bautenschutzgewerbe | 29.00% | Supervisors in painting, varnishing, stucco work, building waterproofing, wood and building protection | Aufsichtskräfte in Malerei, Lackiererei, Stuckateurarbeiten, Bauwerksabdichtung, Holz- und Bauterschutz | 6,487 | 32.50% |
| 50 Master craftsman–Protection and safety | Meister/in-Schutz und Sicherheit | 0.00% | Supervisors in object, personal and fire protection, work safety | Aufsichtskräfte in Objekt-, Personen-, Brandschutz, Arbeitssicherheit | 6,487 | 0.00% |
| 51 Engineer–Horticulture | Ingenieur/in-Gartenbau | 35.00% | Experts in horticulture (without specialization) | Experten im Gartenbau (ohne Spezialisierung) | 1,692 | 35.00% |
| 52 Business economist (university) - Bank und Finanzdienstl | Betriebswirt/in (Hochschule)- Bank und Finanzdienstl | 39.00% | Experts in investment consulting and other financial services | Experten in Anlageberatung und sonstigen Finanzdienstleistungen | 15,595 | 39.00% |
| 53 Engineer–safety engineering | Ingenieur/in–Sicherheitstechnik | 11.00% | Experts in occupational safety and safety technology | Experten in Arbeitssicherheit und Sicherheitstechnik | 20,172 | 11.00% |
| 54 Engineer–Waste Management | Ingenieur/in–Abfallwirtschaft | 20.00% | Experts in waste management | Experten in der Abfallwirtschaft | 896 | 20.00% |
| 55 Architect | Architekt/in | 21.00% | Experts in architecture | Experten in der Architektur | 69,594 | 21.00% |
| 56 Business economist (university) - Construction industry | Betriebswirt/in (Hochschule)- Bauwirtschaft | 29.00% | Experts in construction accounting and costing | Experten in der Bauabrechnung und -kalkulation | 333 | 29.00% |
| 57 Civil servant–Higher civil engineering service | Beamter/in - Höherer bautechnischer Dienst | 17.00% | Experts in construction planning and supervision (without specialisation) | Experten in der Bauplanung und -überwachung (ohne Spezialisierung) | 54,432 | 15.50% |
| 58 Engineer–Construction | Ingenieur/in–Bau | 14.00% | Experts in construction planning and supervision (without specialisation) | Experten in der Bauplanung und -überwachung (ohne Spezialisierung) | 54,432 | 15.50% |
| 59 Engineer–Building Physics | Ingenieur/in–Bauphysik | 40.00% | Experts in construction expertise and construction control | Experten in der Bausachverständigung und Baustelle | 1,194 | 40.00% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|---------------------------------|----------------------------------------------------|--------------------------------|--------------------------------|----------------|-----------------------------------------------------|
| 60 Engineer–building materials | Ingenieur/in–Baustoffe          | 50.00%                                             | Experts in building material testing | Experten in der Baustoffprüfung | 154            | 50.00%                                             |
| 61 Engineer–Building Technology/Facility Management | Ingenieur/in–Gebäudetechnik/ Facility-Management | 55.00%                                             | Experts in building services engineering (without specialisation) | Experten in der Gebäudetechnik (ohne Spezialisierung) | 2,999          | 55.00%                                             |
| 62 Engineer–Geotechnics | Ingenieur/in–Geotechnik         | 40.00%                                             | Experts in geotechnics | Experten in der Geotechnik | 942            | 40.00%                                             |
| 63 Engineer–Wood Technology | Ingenieur/in–Holztechnik        | 50.00%                                             | Experts in woodworking and wood processing (without specialisation) | Experten in der Holzbe- und -verarbeitung (ohne Spezialisierung) | 762            | 50.00%                                             |
| 64 Business economist (university) - Real estate | Betriebswirt/in (Hochschule) - Immobilien | 32.00%                                             | Experts in real estate marketing and management | Experten in der Immobilienvermarktung und -verwaltung | 1,478          | 32.00%                                             |
| 65 Engineer–Information and communication technology | Ingenieur/in - Informations-, Kommunikationstechnik | 50.00%                                             | Experts in information and telecommunications technology | Experten in der Informations- und Telekommunikationstechnik | 13,674         | 50.00%                                             |
| 66 Interior designer | Innenarchitekt/in               | 40.00%                                             | Experts in interior design | Experten in der Innenarchitektur | 5,022          | 40.00%                                             |
| 67 Design engineer (m/f) | Konstruktionsingenieur/in       | 38.00%                                             | Experts in design and equipment construction | Experten in der Konstruktion und im Gerätebau | 14,052         | 38.00%                                             |
| 68 Urban and regional planner | Stadt- und Regionalplaner/in   | 0.00%                                              | Experts in urban and spatial planning | Experten in der Stadt- und Raumplanung | 5,714          | 0.00%                                              |
| 69 IT engineer | Ingenieur/informatiker/in       | 17.00%                                             | Experts in technical computer science | Experten in der technischen Informatik | 3,622          | 17.00%                                             |
| 70 Civil servant–Surveying (high technical service) | Beamter(in) - Vermessungswesen (höh. techn. Dienst) | 88.00%                                             | Experts in surveying technology | Experten in der Vermessungstechnik | 7,314          | 77.00%                                             |
| 71 Civil servant–Surveying (high technical service) | Beamter(in) - Vermessungswesen (höh. techn. Dienst) | 88.00%                                             | Experts in surveying technology | Experten in der Vermessungstechnik | 7,314          | 77.00%                                             |
| 72 Surveying engineer | Vermessungingenieur/in          | 55.00%                                             | Experts in surveying technology | Experten in der Vermessungstechnik | 7,314          | 77.00%                                             |
| 73 Engineer–Water Management | Ingenieur/in–Wasserwirtschaft  | 0.00%                                              | Experts in water management | Experten in der Wasserwirtschaft | 1,730          | 0.00%                                              |

(continued)
| Occupation title (English name) | Occupation title (German name) | Occupation group (German name) | Averaged automation probability per occupation title (in %) | Employee count |
|--------------------------------|--------------------------------|--------------------------------|------------------------------------------------------------|----------------|
| 74 Engineer – Glass, Ceramics, Binders | Ingenieur/in – Glas, Keramik, Bindemittel | 3,000 | 70.00% | 74,000 |
| 75 Security manager | Sicherheitsmanager/in | 10.00% | Experts in materials technology | 3,000 |
| 76 Building and object coater | Bauten- und Objektbeschichter/in | 38.00% | Specialists for painting and varnishing work (other specific information) | 113,616 |
| 77 Painter and varnisher | Maler/in und Lackierer/in | 29.00% | Specialists for painting and varnishing work | 113,616 |
| 78 Painter and varnisher – design and maintenance | Maler/in und Lackierer/in – Gestaltung und Instandhaltung | 29.00% | Specialists for painting and varnishing work | 113,616 |
| 79 Painter and varnisher – Church painting and monument preservation | Maler/in und Lackierer/in – Kirchenmalerei und Denkmalpflege | 25.00% | Specialists for painting and varnishing work | 113,616 |
| 80 Expansion manager | Ausbaumanager/in | 30.00% | Specialists for stucco work | 16,921 |
| 81 Finishing skilled worker | Ausbaurüstungsarbeiter/in | 0.00% | Skilled workers in dry and wet construction (without specialisation) | 20,588 |
| 82 Drywall fitter | Trockenbaumeister/in | 13.00% | Skilled workers in dry and wet construction (without specialisation) | 20,588 |
| 83 Building mechanic for demolition and concrete separation technology | Bauwerksmechaniker/in für Abbruch und Betontrenntechnik | 0.00% | Skilled workers in dry and wet construction (without specialisation) | 727 |

Table AI.
| Occupation title (English name) | Occupation title (German name) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|---------------------------------|--------------------------------|---------------|----------------------------------------------------------|
| 84 Mining and mechanical engineer–Transport and maintenance | Berg- und Maschinenmann/-frau - Transport und Instandhaltung | Specialists in mining and surface mining | Fachkräfte im Berg- und Tagebau | 13,577 | 79.83% |
| 85 Mining and machine operator–tunnelling and extraction | Berg- und Maschinenmann/-frau - Vortrieb und Gewinnung | Specialists in mining and surface mining | Fachkräfte im Berg- und Tagebau | 13,577 | 79.83% |
| 86 Mining Technologist–Civil Engineering | Bergbautechnologe/-technologin - Tiefbautechnik | Specialists in mining and surface mining | Fachkräfte im Berg- und Tagebau | 13,577 | 79.83% |
| 87 Mining technologist–Deep drilling technology | Bergbautechnologe/-technologin - Tiefbohrtechnik | Specialists in mining and surface mining | Fachkräfte im Berg- und Tagebau | 13,577 | 79.83% |
| 88 Mining Technologist–Civil Engineering | Bergbautechnologe/-technologin - Tiefbautechnik | Specialists in mining and surface mining | Fachkräfte im Berg- und Tagebau | 13,577 | 79.83% |
| 89 Mining technologist–Deep drilling technology | Bergbautechnologe/-technologin - Tiefbohrtechnik | Specialists in mining and surface mining | Fachkräfte im Berg- und Tagebau | 13,577 | 79.83% |
| 90 Concrete and reinforced concrete constructor | Beton- und Stahlbetonbauer/in | Specialists in concrete and reinforced concrete construction | Fachkräfte im Beton- und Stahlbetonbau | 33,184 | 17.00% |
| 91 Concrete and reinforced concrete constructor | Beton- und Stahlbetonbauer/in | Specialists in concrete and reinforced concrete construction | Fachkräfte im Beton- und Stahlbetonbau | 33,184 | 17.00% |
| 92 Scaffolder | Gerüstbauer/in | Specialists in scaffolding construction | Fachkräfte im Gerüstbau | 11,873 | 0.00% |
| 93 Skilled construction worker | Hochbaufacharbeiter/in | Specialists in building construction (without specialisation) | Fachkräfte im Hochbau (ohne Spezialisierung) | 57,669 | 0.00% |
| 94 Skilled worker–wood and building protection work | Fachkraft - Holz- und Bautenschutzarbeiten | Specialists in wood and building protection | Fachkräfte im Holz- und Bautenschutz | 1,407 | 37.00% |
| 95 Wood and building protector–Building protection | Holz- und Bautenschützer/in–Bautenschutz | Specialists in wood and building protection | Fachkräfte im Holz- und Bautenschutz | 1,407 | 37.00% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|-------------------------------|--------------------------------|-----------------------------------------------|-------------------------------|-------------------------------|----------------|-----------------------------------------------|
| 96 Wood and building protector – Wood protection | Holz- und Bautenschützer/in – Holzschutz | 43.00% | Specialists in wood and building protection | Fachkräfte im Holz- und Bautenschutz | 1,407 | 37.00% |
| 97 Specialist – Furniture, kitchen and moving service | Fachkraft - Möbel-, Küchen- und Umzugsservice | 38.00% | Specialists in woodworking, furniture and interior design | Fachkräfte im Holz-, Möbel- und Innenausbau | 14,261 | 55.75% |
| 98 Wood mechanic (m/f) – manufacturer Building element, wooden pack and frame | Holzmechaniker/in-Herst. v. Bauelement, Holzpackm. u. Rahmen | 80.00% | Specialists in woodworking, furniture and interior design | Fachkräfte im Holz-, Möbel- und Innenausbau | 14,261 | 55.75% |
| 99 Wood mechanics/ manufacturers of furniture and interior components | Holzmechaniker/in-Herstellen v. Möbeln u. Innenausbauten | 67.00% | Specialists in woodworking, furniture and interior design | Fachkräfte im Holz-, Möbel- und Innenausbau | 14,261 | 55.75% |
| 100 Wood mechanic/ assembler. of interior fittings and construction elements | Holzmechaniker/in-Montier. v. Innenausbaut. u. Bauelementen | 38.00% | Specialists in woodworking, furniture and interior design | Fachkräfte im Holz-, Möbel- und Innenausbau | 14,261 | 55.75% |
| 101 Canal builder | Kanalbauer/in | 0.00% | Specialists in canal and tunnel construction | Fachkräfte im Kanal- und Tunnelbau | 3,777 | 0.00% |
| 102 Hydraulic engineer | Wasserbauer/in | 0.00% | Specialists in cultural and hydraulic engineering | Fachkräfte im Kultur- und Wasserbau | 5,636 | 0.00% |
| 103 Bricklayer | Maurer/in | 0.00% | Specialists in the bricklaying trade | Fachkräfte im Maurerhandwerk | 92,388 | 0.00% |
| 104 Specialist for metal technology – construction technology | Fachkraft für Metalltechnik-Konstruktionstechnik | 86.00% | Specialists in metal construction | Fachkräfte im Metallbau | 216,635 | 85.00% |
| 105 Construction mechanic | Konstruktionsmechaniker/in | 86.00% | Specialists in metal construction | Fachkräfte im Metallbau | 216,635 | 85.00% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|-----------------------------------------------|---------------------------------|--------------------------------|----------------|----------------------------------------------------------|
| 106 Metalworker–Construction technology | Metallbauer/in–Konstruktionstechnik | 83.00% | Specialists in metal construction | Fachkräfte im Metallbau | 216,635 | 85.00% |
| 107 Technical model maker–view | Technische/r Modellbauer/in–Anschauung | 90.00% | Specialists in model making | Fachkräfte im Modellbau | 9,917 | 96.67% |
| 108 Technical model maker–foundry | Technische/r Modellbauer/in–Gießerei | 100.00% | Specialists in model making | Fachkräfte im Modellbau | 9,917 | 96.67% |
| 109 Technical model maker–bodywork and production protective and security force | Technische/r Modellbauer/in–Karosserie und Produktion | 100.00% | Specialists in model making | Fachkräfte im Modellbau | 9,917 | 96.67% |
| 110 Protective and security force | Schutz- und Sicherheitskraft | 0.00% | Specialists in object, value and personal protection | Fachkräfte im Objekt-, Wert- und Personenschutz | 189,637 | 0.00% |
| 111 Furnace and air heating engineer | Ofen- und Luftheizungsbauer/in | 17.00% | Specialists in furnace and air heating construction | Fachkräfte im Ofen- und Luftheizungsbau | 2,371 | 17.00% |
| 112 Assistant–Product Design | Assistent/in–Produktdesign | 0.00% | Specialists in product and industrial design | Fachkräfte im Produkt- und Industriedesign | 2,680 | 0.00% |
| 113 Pipeline builder | Rohrleitungsbauer/in | 20.00% | Specialists in pipeline construction | Fachkräfte im Rohrleitungsbau | 22,973 | 20.00% |
| 114 Roller shutter and sun protection mechatronics technician | Rollladen- und Sonnenschutzmechatroniker/in | 43.00% | Specialists in the construction of roller shutters and venetian blinds | Fachkräfte im Rollladen- und Jakusiebau | 4,963 | 43.00% |
| 115 Firing and chimney builder | Feuerungs- und Schornsteinbauer/in | 0.00% | Specialists in chimney construction | Fachkräfte im Schornsteinbau | 1,476 | 0.00% |
| 116 Asphalt farmer | Asphaltbauer/in | 20.00% | Specialists in road and asphalt construction | Fachkräfte im Straßen- und Asphaltbau | 33,686 | 10.00% |
| 117 Road builder | Straßenbauer/in | 0.00% | Specialists in road and asphalt construction | Fachkräfte im Straßen- und Asphaltbau | 33,686 | 10.00% |
| 118 Special civil engineer | Spezalitätenbauer/in | 10.00% | Specialists in civil engineering (without specialisation) | Fachkräfte im Tiefbau (ohne Spezialisierung) | 32,020 | 5.00% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|---------------------------------------------------|--------------------------------|--------------------------------|----------------|----------------------------------------------------------|
| 119 Civil engineering skilled worker | Tiefbaufacharbeiter/in | 0.00% | Specialists in civil engineering (without specialisation) | Fachkräfte im Tiefbau (ohne Spezialisierung) | 32,020 | 5.00% |
| 120 Furnishing consultant | Einrichtungsfachberater/in | 50.00% | Specialists in the sale of furniture and furnishings | Fachkräfte im Verkauf von Möbeln und Einrichtungsgegenständen | 41,616 | 50.00% |
| 121 Financial assistant | Finanzassistent/in | 73.00% | Investment advisory and other financial services professionals | Fachkräfte in Anlageberatung und sonstigen Finanzdienstleistungen | 6,305 | 73.00% |
| 122 Specialist–recycling and waste management | Fachkraft - Kreislauf- und Abfallwirtschaft | 33.00% | Specialists in waste management | Fachkräfte in der Abfallwirtschaft | 10,184 | 33.00% |
| 123 Electronics technician–automation technology (handicraft) | Elektroniker/in–Automatisierungstechnik (Handwerk) | 75.00% | Specialists in automation technology | Fachkräfte in der Automatisierungstechnik | 21,777 | 75.00% |
| 124 Electronics Technician–Automation Technology (industry) | Elektroniker/in–Automatisierungstechnik (Industri, i.e.) | 75.00% | Specialists in automation technology | Fachkräfte in der Automatisierungstechnik | 21,777 | 75.00% |
| 125 Electronics Technician–Energy and Building Technology | Elektroniker/in - Energie- und Gebäudetechnik | 75.00% | Specialists in construction electrics | Fachkräfte in der Bauelektrik | 224,334 | 75.00% |
| 126 Electronics Technician–Building and Infrastructure Systems | Elektroniker/in - Gebäude- und Infrastruktursysteme | 75.00% | Specialists in construction electrics | Fachkräfte in der Bauelektrik | 224,334 | 75.00% |
| 127 Technical Assistant–Structural Engineering | Techn. Assistent/in–Bautechnik | 50.00% | Specialists in construction planning and supervision (without specialisation) | Fachkräfte in der Bauplanung und -überwachung (ohne Spezialisierung) | 9,894 | 50.00% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|-----------------------------------------------------|--------------------------------|--------------------------------|----------------|----------------------------------------------------------|
| 128 Specialist–road and traffic engineering | Fachkraft - Straßen- und Verkehrstechnik | 50.00% | Specialists in the construction planning of traffic routes and facilities | Fachkräfte in der Bauplanung von Verkehrswegen und Anlagen | 347 | 50.00% |
| 129 Precast concrete constructor | Betonfertigteilebauer/in | 50.00% | Specialists in the production of building materials | Fachkräfte in der Baustoffherstellung | 21,292 | 79.57% |
| 131 Process mechanic - stone-/earth-based building materials | Verfahrensmechaniker/in - Steine-/Erdenind. - Baustoffe | 100.00% | Specialists in the production of building materials | Fachkräfte in der Baustoffherstellung | 21,292 | 79.57% |
| 132 Process mechanic - Stone-/Earth-Industrial - Plasterplast/fibre ore | Verfahrensmechaniker/in - Steine-/Erdenind.- Gipspl./Faserz | 100.00% | Specialists in the production of building materials | Fachkräfte in der Baustoffherstellung | 21,292 | 79.57% |
| 133 Process mechanic - stone-/soilind.- lime./ pores | Verfahrensmechaniker/in - Steine-/Erdenind.- Kalks./Porenb | 100.00% | Specialists in the production of building materials | Fachkräfte in der Baustoffherstellung | 21,292 | 79.57% |
| 134 Process mechanic - Rock/soil aggregate ready-mixed concrete | Verfahrensmechaniker/in - Steine-/Erdenind.- Transportbeton | 100.00% | Specialists in the production of building materials | Fachkräfte in der Baustoffherstellung | 21,292 | 79.57% |
| 135 Process mechanic - stone-/soil-prec. concrete ore | Verfahrensmechaniker/in - Steine-/Erdenind.- vorg Betonerz | 57.00% | Specialists in the production of building materials | Fachkräfte in der Baustoffherstellung | 21,292 | 79.57% |
| 136 Building material tester | Baustoffprüfer/in | 86.00% | Specialists in building material testing | Fachkräfte in der Baustoffprüfung | 4,002 | 86.00% |
| 137 Building sealer | Bauwerksabdichter/in | 50.00% | Specialists in waterproofing buildings | Fachkräfte in der Bauwerksabdichtung | 2,889 | 50.00% |
| 138 Technical Assistant for the Monument | Denkmalaufgebote Assistent/in | 60.00% | Specialists in building maintenance and renewal | Fachkräfte in der Bauwerkserhaltung und -erneuerung | 719 | 60.00% |
| 139 Roofer | Dachdecker/in | 0.00% | Specialists in the roofing trade | Fachkräfte in der Dachdeckerei | 49,809 | 0.00% |
| 140 Electronics technician - industrial engineering | Elektroniker/in-Betriebstechnik | 70.00% | Specialists in electrical operating technology | Fachkräfte in der elektrischen Betriebstechnik | 116,174 | 70.00% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|---------------------------------|---------------------------------|-----------------------------------------------|---------------------------------|---------------------------------|----------------|----------------------------------------------------------|
| 141 Electrical engineering assistant | Elektrotechnische/r Assistent/in | 100.00% | Specialists in electrical engineering (without specialization) | Fachkräfte in der Elektrotechnik (ohne Spezialisierung) | 31,722 | 100.00% |
| 142 Screed layer | Estrichleger/in | 33.00% | Specialists in screed and terrazzo laying | Fachkräfte in der Estrich- und Terrazzoverlegung | 4,365 | 33.00% |
| 143 Tile, slab and mosaic layers | Fliesen-, Platten- und Mosaikeleger/in | 20.00% | Specialists in the laying of tiles, slabs and mosaics | Fachkräfte in der Fliesen-, Platten- und Mosaikverlegung | 26,317 | 20.00% |
| 144 Building cleaner | Gebäudereiniger/in | 13.00% | Specialists in building cleaning | Fachkräfte in der Gebäudereinigung | 101,587 | 13.00% |
| 145 Housekeeper/House technician | Hauswart/in/Haustechniker/in | 40.00% | Specialists in building services engineering (without specialisation) | Fachkräfte in der Gebäudetechnik (ohne Spezialisierung) | 233,272 | 66.00% |
| 146 Technical Assistant – Building Services Engineering | Techn. Assistent/in–Gebäudetechnik | 92.00% | Specialists in building services engineering (without specialisation) | Fachkräfte in der Gebäudetechnik (ohne Spezialisierung) | 233,272 | 66.00% |
| 147 Glazier – Window and glass facade construction | Glaser/in - Fenster- und Glasfassadenbaur | 29.00% | Specialists in the glazier’s shop | Fachkräfte in der Glaserei | 9,770 | 44.50% |
| 148 Glazier – Glazing and glass construction | Glaser/in-Verglasung und Glasbau | 60.00% | Specialists in the glazier’s shop | Fachkräfte in der Glaserei | 9,770 | 44.50% |
| 149 Glassmaker | Glasmacher/in | 100.00% | Specialists in glass production | Fachkräfte in der Glasherstellung | 9,556 | 100.00% |
| 150 Housekeeper | Hauswirtschafter/in | 38.00% | Specialists in home economics | Fachkräfte in der Hauswirtschaft | 85,530 | 35.50% |
| 151 Domestic helper/assistant | Hauswirtschaftshelfer/in/-assistent/in | 33.00% | Specialists in home economics | Fachkräfte in der Hauswirtschaft | 85,530 | 35.50% |
| 152 Woodworking mechanic | Holzbearbeitungsmechaniker/in | 86.00% | Skilled workers in woodworking and wood processing (without specialisation) | Fachkräfte in der Holzbearbeitung (ohne Spezialisierung) | 14,498 | 86.00% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|-------------------------------|--------------------------------|-----------------------------------------------|--------------------------------|--------------------------------|----------------|------------------------------------------------|
| 153 Real estate assistant      | Immobilienassistent/in        | 25.00%                                        | Experts in real estate marketing and management | Fachkräfte in der Immobilienvermarktung und -verwaltung | 33,796          | 25.00%                                           |
| 154 Real estate agent          | Immobilienkaufmann/-frau      | 25.00%                                        | Experts in real estate marketing and management | Fachkräfte in der Immobilienvermarktung und -verwaltung | 33,796          | 25.00%                                           |
| 155 Technical-commercial assistant–building services | Technisch-kaufmännische/r Assistent/in–Gebäudeservice | 25.00%                                        | Experts in real estate marketing and management | Fachkräfte in der Immobilienvermarktung und -verwaltung | 33,796          | 25.00%                                           |
| 156 Industrial ceramist (m/f) in model technology | Industriekeramiker/in Modelltechnik | 100.00%                                       | Specialists in industrial ceramics (model technology) | Fachkräfte in der Industriekeramik (Modelltechnik) | 981            | 100.00%                                          |
| 157 Industrial ceramist (m/f) in plant engineering | Industriekeramiker/in Anlagentechnik | 92.00%                                        | Specialists in industrial ceramics (process and plant engineering) | Fachkräfte in der Industriekeramik (Verfahrens- und Anlagentechnik) | 4,104          | 96.00%                                           |
| 158 Industrial ceramist in process engineering | Industriekeramiker/in Verfahrenstechnik | 100.00%                                       | Specialists in industrial ceramics (process and plant engineering) | Fachkräfte in der Industriekeramik (Verfahrens- und Anlagentechnik) | 4,104          | 96.00%                                           |
| 159 Electronics technician–Information and telecommunications technology | Elektroniker/in - Informations- u. Tekommunikationstechnik | 100.00%                                       | Specialists in information and telecommunications technology | Fachkräfte in der Informations- und Telekommunikationstechnik | 141,812        | 94.33%                                           |
| 160 Electronics Technician–Information and Systems Technology Information electronics technician | Elektroniker/in - Informations- und Systemtechnik | 83.00%                                        | Specialists in information and telecommunications technology | Fachkräfte in der Informations- und Telekommunikationstechnik | 141,812        | 94.33%                                           |
| 161 Assistant–Interior Architecture | Assistent/in–Innenarchitektur | 20.00%                                        | Specialists in interior design                     | Fachkräfte in der Innenarchitektur                     | 384            | 20.00%                                           |
| 162 Insulation technician      | Isolierfacharbeiter/in        | 20.00%                                        | Specialists in insulation                          | Fachkräfte in der Isolierung                          | 11,464         | 10.00%                                           |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|-------------------------------|--------------------------------|---------------------------------------------------|-------------------------------|--------------------------------|----------------|---------------------------------------------------------|
| 164 Heat, cold and sound insulation specialist | Wärme-, Kälte- und Schallschutzisolierer/in | 0.00% | Specialists in insulation | Fachkräfte in der Isolierung | 11,464 | 10.00% |
| 165 Plant assistant–Craft trades | Betriebsassistent/in–Handwerk | 40.00% | Skilled workers in commercial and technical business administration (without specialisation) | Fachkräfte in der kaufmännischen und technischen Betriebswirtschaft (ohne Spezialisierung) | 936,387 | 44.00% |
| 166 Plant assistant–Craft trades | Betriebsassistent/in–Handwerk | 40.00% | Skilled workers in commercial and technical business administration (without specialisation) | Fachkräfte in der kaufmännischen und technischen Betriebswirtschaft (ohne Spezialisierung) | 936,387 | 44.00% |
| 167 Industrial clerk (m/f) | Industriekaufmann/-frau | 56.00% | Skilled workers in commercial and technical business administration (without specialisation) | Fachkräfte in der kaufmännischen und technischen Betriebswirtschaft (ohne Spezialisierung) | 936,387 | 44.00% |
| 168 Technical business economist–Craftsmanship | Technische/r Betriebswirt/in–Handwerk | 40.00% | Skilled workers in commercial and technical business administration (without specialisation) | Fachkräfte in der kaufmännischen und technischen Betriebswirtschaft (ohne Spezialisierung) | 936,387 | 44.00% |
| 169 Plumber | Klempner/in | 71.00% | Specialists in plumbing (without specialisation) | Fachkräfte in der Klempnerei (ohne Spezialisierung) | 17,516 | 71.00% |
| 170 Industrial Ceramist Decoration Technology | Industriekeramiker/in–Dekorationstechnik | 100.00% | Specialists in handicraft glass, ceramic and porcelain painting | Fachkräfte in der kunsthandwerklichen Glas-, Keram- und Porzellanmalerei | 1,030 | 100.00% |
| 171 Ceramist | Keramiker/in | 80.00% | Professionals in the craft of ceramics design | Fachkräfte in der kunsthandwerklichen Keramikgestaltung | 2,583 | 80.00% |
| 172 Parquet layer | Parkettleger/in | 50.00% | Specialists in parquet laying | Fachkräfte in der Parkettverlegung | 4,440 | 50.00% |
| 173 Interior decorator | Raumausstatter/in | 13.00% | Specialists in room furnishing | Fachkräfte in der Raumausstattung | 18,210 | 13.00% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|---------------------------------------------------|--------------------------------|---------------------------------|---------------|----------------------------------------------------------|
| 174 Plant mechanic–Sanitary, heating and air-conditioning technology | Anlagenmechaniker/in - Sanitär-, Heizungs- und Klimatechnik | 70.00% | Specialists in sanitary, heating and air-conditioning technology | Fachkräfte in der Sanitär-, Heizungs- und Klimatechnik | 171,535 | 70.00% |
| 175 Specialist for metal technology–Forming and wire technology | Fachkraft für Metalltechnik - Umform- und Drahttechnik | 83.00% | Specialists in non-cutting metalworking | Fachkräfte in der spanlosen Metallbearbeitung | 25,275 | 83.00% |
| 176 Civil servant (m/f) - Surveying (middle technical service) | Beamte(in) - Vermessungswesen (mittl. techn. Dienst) | 88.00% | Specialists in surveying technology | Fachkräfte in der Vermessungstechnik | 18,230 | 69.00% |
| 177 Civil servant (m/f) - Surveying (middle technical service) | Beamte(in) - Vermessungswesen (mittl. techn. Dienst) | 88.00% | Specialists in surveying technology | Fachkräfte in der Vermessungstechnik | 18,230 | 69.00% |
| 178 Surveying technician–mountain surveying | Vermessungstechniker/in–Bergvermessung | 50.00% | Specialists in surveying technology | Fachkräfte in der Vermessungstechnik | 18,230 | 69.00% |
| 179 Surveying technician–Surveying | Vermessungstechniker/in–Vermessung | 50.00% | Specialists in surveying technology | Fachkräfte in der Vermessungstechnik | 18,230 | 69.00% |
| 180 Specialist–Sewage technology | Fachkraft–Abwassertechnik | 60.00% | Specialists in water supply and waste water technology | Fachkräfte in der Wasserversorgungs- und Abwassertechnik | 26,160 | 77.00% |
| 181 Specialist–Pipe, sewer and industrial services | Fachkraft - Rohr-, Kanal- und Industrieservice | 100.00% | Specialists in water supply and waste water technology | Fachkräfte in der Wasserversorgungs- und Abwassertechnik | 26,160 | 77.00% |
| 182 Specialist–Water supply engineering | Fachkraft–Wasserversorgungstechnik | 71.00% | Specialists in water supply and waste water technology | Fachkräfte in der Wasserversorgungs- und Abwassertechnik | 26,160 | 77.00% |
| 183 Specialist–Water Management | Fachkraft–Wasserwirtschaft | 56.00% | Specialists in water supply and waste water technology | Fachkräfte in der Wasserversorgungs- und Abwassertechnik | 1,218 | 56.00% |
| 184 Carpenter/room owner | Zimmerer/Zimmerin | 13.00% | Specialists in carpentry | Fachkräfte in der Zimmerei | 50,621 | 13.00% |
| 185 Construction equipment operator | Baugeräteführer/in | 0.00% | Drivers of earthmoving and related machinery | Führer/innen von Erdbewegungs- und verwandten Maschinen | 49,472 | 0.00% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averageed automation probability per occupation group (in %) |
|-------------------------------|--------------------------------|-----------------------------------------------|--------------------------------|--------------------------------|----------------|-------------------------------------------------------------|
| 186 Wood farmer               | Holzwirt/in                   | 55.00%                                        | Executives in woodworking and wood processing | Führungskräfte in der Holzbe- und-Verarbeitung | 189            | 55.00%                                                      |
| 187 Banker (m/f)              | Bankkaufmann/-frau             | 88.00%                                        | Commercial banking specialists      | Kaufmännische Bankfachkräfte | 431,547        | 88.00%                                                      |
| 188 Business administrator–Bank | Fachwirt/in–Bank             | 50.00%                                        | Commercial banking specialists      | Kaufmännische Bankspezialisten | 332,220        | 50.00%                                                      |
| 189 Business economist (university) – Commerce | Betriebswirt/in (Hochschule) - Handel | 41.00%                                        | Commercial experts in trade (without specialization) | Kaufmännische Experten im Handel (ohne Spezialisierung) | 558            | 41.00%                                                      |
| 190 Business administrator–Trade | Fachwirt/in–Handel           | 42.00%                                        | Commercial specialists in trade (without specialization) | Kaufmännische Spezialisten im Handel (ohne Spezialisierung) | 17,302         | 42.00%                                                      |
| 191 Technical specialist (m/f) - hardware technology | Technische/r Fachkaufmann/-frau - Beschlagtechnik | 44.00%                                        | Commercial specialists in trade (other specific activity information) | Kaufmännische Spezialisten im Handel (sonstige spezifische Tätigkeitsangabe) | 3,608           | 46.67%                                                      |
| 192 Technical specialist–sanitary/heating/air conditioning | Technische/r Fachkaufmann/-frau - Sanitär/Heizung/Klima | 58.00%                                        | Commercial specialists in trade (other specific activity information) | Kaufmännische Spezialisten im Handel (sonstige spezifische Tätigkeitsangabe) | 3,608           | 46.67%                                                      |
| 193 Technical specialist (m/f) - tools/machines | Technische/r Fachkaufmann/-frau - Werkzeuge/Maschinen | 38.00%                                        | Commercial specialists in trade (other specific activity information) | Kaufmännische Spezialisten im Handel (sonstige spezifische Tätigkeitsangabe) | 3,608           | 46.67%                                                      |
| 194 Insurance specialist     | Versicherungsfachmann/-frau   | 63.00%                                        | Commercial insurance specialists     | Kaufmännische Versicherungsfachkräfte | 135,493         | 63.00%                                                      |
| 195 Business Administrator–Insurance and Finance | Fachwirt/in–Versicherungen und Finanzen | 58.00%                                        | Commercial insurance specialists     | Kaufmännische Versicherungspflichten | 42,753          | 58.00%                                                      |
| 196 Notary                   | Notar/-                       | 33.00%                                        | Notaries (m/f)                      | Notare/Notarinnen               | 2,906           | 33.00%                                                      |
| 197 Specialist attorney at law | Fachanwalt/-anwältin         | 20.00%                                        | Attorneys at law                    | Rechtsanwälte/anwältinnen       | 33,887          | 20.00%                                                      |
| 198 Chimney sweep            | Schornsteinfeger/-innen       | 20.00%                                        | Chimney sweeps                      | Schornsteinfeger/-innen         | 8,892           | 20.00%                                                      |
| 199 painter and varnisher–restoration work | Maler/-und Lackierer/-Restaurierungsarbeiten | 33.00%                                        | Specialists for painting and varnishing work | Maler- und Lackiererarbeiten | 396             | 32.00%                                                      |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|-----------------------------------------------|---------------------------------|--------------------------------|----------------|-----------------------------------------------|
| 200 Restorer–painter and varnisher craft | Restaurator/in - Maler- und Lackiererhandwerk | 31.00% | Specialists for painting and varnishing work | Spezialisten für Maler- und Lackierarbeiten | 396 | 32.00% |
| 201 Technician–Civil engineering (extension) | Techniker/in–Bautechnik (Ausbau) | 40.00% | Specialists in dry and drywall construction (without specialisation) | Spezialisten im Aus- und Trockenbau (ohne Spezialisierung) | 539 | 40.00% |
| 202 Technician–Civil engineering (concrete construction) | Techniker/in–Bautechnik (Betonbau) | 40.00% | Specialists in concrete and reinforced concrete construction | Spezialisten im Beton- und Stahlbetonbau | 834 | 40.00% |
| 203 fire protection specialist | Brandschutzfachkraft | 25.00% | Fire protection specialists | Spezialisten im Brandschutz | 3,865 | 25.00% |
| 204 Specialist–building management | Fachmann/frau - Gebäudewirtschaft | 25.00% | Specialists in Facility Management | Spezialisten im Facility-Management | 9,201 | 46.67% |
| 205 Business administrator–Facility Management | Fachwirt/in - Facility-Management | 55.00% | Specialists in Facility Management | Spezialisten im Facility-Management | 9,201 | 46.67% |
| 206 Facility Manager | Facility-Manager/in | 60.00% | Specialists in Facility Management | Spezialisten im Facility-Management | 9,201 | 46.67% |
| 207 Technician–Civil engineering (structural engineering) | Techniker/in–Bautechnik (Hochbau) | 50.00% | Specialists in building construction (without specialisation) | Spezialisten im Hochbau (ohne Spezialisierung) | 4,633 | 50.00% |
| 208 Restorer–Furniture and wooden objects | Restaurator/in–Möbel und Holzobjekte | 54.00% | Specialists in wood, furniture and interior construction | Spezialisten im Holz-, Möbel- und Innenraum | 2,678 | 52.00% |
| 209 Technician–wood technology (furniture construction and interior design) | Techniker/in–Holztechnik (Möbelbau und Raumgestaltung) | 50.00% | Specialists in wood, furniture and interior construction | Spezialisten im Holz-, Möbel- und Innenraum | 2,678 | 52.00% |
| 210 Bricklayer–Restoration work | Maurer/in–Restaurierungsarbeiten | 0.00% | Specialists in the bricklaying trade | Spezialisten im Maurerhandwerk | 313 | 6.50% |
| 211 Restorer–Masonry trade | Restaurator/in–Maurerhandwerk | 13.00% | Specialists in the bricklaying trade | Spezialisten im Maurerhandwerk | 313 | 6.50% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|------------------------------------------------|---------------------------------|--------------------------------|----------------|--------------------------------|
| 212 Technician–metal construction technology (steel construction) | Techniker/in–Metallbautechnik (Stahlbau) | 63.00% | Specialists in metal construction | Spezialisten im Metallbau | 3,962 | 63.00% |
| 213 Technician–Civil engineering (civil engineering) | Techniker/in–Bautechnik (Tiefbau) | 50.00% | Specialists in civil engineering (without specialisation) | Spezialisten im Tiefbau (ohne Spezialisierung) | 2,011 | 50.00% |
| 214 Consultant–Financial Services | Fachberater/in–Finanzdienstleistungen | 43.00% | Specialists in investment advice and other financial services | Spezialisten in Anlageberatung und sonstigen Finanzdienstleistungen | 14,741 | 47.33% |
| 215 Business administrator–financial consultancy | Fachwirt/in–Finanzberatung | 44.00% | Specialists in investment advice and other financial services | Spezialisten in Anlageberatung und sonstigen Finanzdienstleistungen | 14,741 | 47.33% |
| 216 Business administrator–Investment | Fachwirt/in–Investment | 55.00% | Specialists in investment advice and other financial services | Spezialisten in Anlageberatung und sonstigen Finanzdienstleistungen | 14,741 | 47.33% |
| 217 Business administrator–Construction | Fachwirt/in–Bau | 60.00% | Specialists in construction accounting and costing | Spezialisten in der Bauabrechnung und -kalkulation | 4,055 | 60.00% |
| 218 Civil servant–Senior civil engineering service | Beamter/in - Gehobener bautechnischer Dienst | 25.00% | Specialists in construction planning and supervision (without specialisation) | Spezialisten in der Bauplanung und -überwachung (ohne Spezialisierung) | 25,456 | 41.67% |
| 219 Technician–Civil engineering (construction operation) | Techniker/in–Bautechnik (Baubetrieb) | 50.00% | Specialists in construction planning and supervision (without specialisation) | Spezialisten in der Bauplanung und -überwachung (ohne Spezialisierung) | 25,456 | 41.67% |
| 220 Technician–Civil engineering (without focus) | Techniker/in–Bautechnik (ohne Schwerpunkt) | 50.00% | Specialists in construction planning and supervision (without specialisation) | Spezialisten in der Bauplanung und -überwachung (ohne Spezialisierung) | 25,456 | 41.67% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|---------------------------------------------------|--------------------------------|--------------------------------|----------------|----------------------------------------------------------|
| 221 Technician–Civil engineering (renovation of a building) | Techniker/in–Bautechnik (Bauerneuerung/Bausanierung) | 40.00% | Specialists in building maintenance and renovation | Spezialisten in der Bauwerkserhaltung und -erneuerung | 1,764 | 40.00% |
| 222 Technician–Electrical engineering (without focus) | Techniker/in–Elektrotechnik (ohne Schwerpunkt) | 88.00% | Specialists in electrical engineering (without specialization) | Spezialisten in der Elektrotechnik (ohne Spezialisierung) | 50,568 | 88.00% |
| 223 Technician–Cleaning and hygiene technology | Techniker/in - Reinigungs- und Hygienetechnik | 40.00% | Specialists in building cleaning | Spezialisten in der Gebäudereinigung | 1,437 | 40.00% |
| 224 Specialist–Building services engineering | Fachkraft–Gebäudetechnik | 90.00% | Specialists in building services engineering (without specialisation) | Spezialisten in der Gebäudetechnik (ohne Spezialisierung) | 13,313 | 83.33% |
| 225 Specialist planner–energy and building technology | Fachplanerin–Energie- und Gebäudeotechnik | 78.00% | Specialists in building services engineering (without specialisation) | Spezialisten in der Gebäudetechnik (ohne Spezialisierung) | 13,313 | 83.33% |
| 226 Technician–building system technology | Techniker/in–Gebäudesystemtechnik | 82.00% | Specialists in building services engineering (without specialisation) | Spezialisten in der Gebäudetechnik (ohne Spezialisierung) | 13,313 | 83.33% |
| 227 Technician–Geological Engineering | Techniker/in–Geologietechnik | 14.00% | Specialists in geotechnics | Spezialisten in der Geotechnik | 739 | 14.00% |
| 228 Technician–glass technology (glass and window construction technology) | Techniker/in–Glastechnik (Glas- und Fensterbautechnik) | 58.00% | Specialists in glass production | Spezialisten in der Glasherstellung | 715 | 70.00% |
| 229 Technician–glass technology (glassworks technology) | Techniker/in–Glastechnik (Glashüttentechnik) | 82.00% | Specialists in glass production | Spezialisten in der Glasherstellung | 715 | 70.00% |
| 230 Specialist housekeeper | Fachhauswirtsin | 38.00% | Specialists in home economics | Spezialisten in der Hauswirtschaft | 3,293 | 40.00% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|---------------------------------|------------------------------------------------|---------------------------------|---------------------------------|----------------|----------------------------------------------------------|
| 231 Technician–Nutrition and Supply Management | Techniker/in - Ernährungs- und Versorgungsmanagement | 44.00% | Specialists in home economics | Spezialisten in der Hauswirtschaft | 3,293 | 40.00% |
| 232 Economist–Home economics | Wirtschafter/in – Hauswirtschaft | 38.00% | Specialists in home economics | Spezialisten in der Hauswirtschaft | 3,293 | 40.00% |
| 233 Technician–Wood technology (model and mould making) | Techniker/in – Holztechnik (Modell- und Formenbau) | 79.00% | Specialists in woodworking and wood processing (without specialisation) | Spezialisten in der Holzbe- und -verarbeitung (ohne Spezialisierung) | 2,303 | 71.00% |
| 234 Technician–Wood technology (without focus) | Techniker/in – Holztechnik (ohne Schwerpunkt) | 63.00% | Specialists in woodworking and wood processing (without specialisation) | Spezialisten in der Holzbe- und -verarbeitung (ohne Spezialisierung) | 2,303 | 71.00% |
| 235 Business economist (technical college) – Real estate | Betriebswirt/in (Fachschule) – Immobilien | 27.00% | Specialists in real estate marketing and management | Spezialisten in der Immobilienvermarktung und -verwaltung | 28,837 | 17.33% |
| 236 Business administrator – Real estate | Fachwirt/in – Immobilien | 25.00% | Specialists in real estate marketing and management | Spezialisten in der Immobilienvermarktung und -verwaltung | 28,837 | 17.33% |
| 237 Real estate expert | Immobilienkaufvermittler/in | 0.00% | Specialists in real estate marketing and management | Spezialisten in der Immobilienvermarktung und -verwaltung | 28,837 | 17.33% |
| 238 Technician–Ceramic Technology | Techniker/in – Keramiktechnik | 73.00% | Specialists in industrial ceramics (process and plant engineering) | Spezialisten in der Industriekeramik (Verfahrens- und Anlagenotechnik) | 215 | 73.00% |
| 239 Technician–Electrical Engineering (Information/ Communication) | Techniker/in – Elektrotechnik (Information/Kommunikation) | 78.00% | Specialists in information and telecommunications technology | Spezialisten in der Informations- und Telekommunikationstechnik | 38,216 | 78.00% |
| 240 Designer–Colour design/room design | Gestalter/in – Farbtechnik/ Raumgestaltung | 0.00% | Specialists in interior design | Spezialisten in der Innenarchitektur | 1,238 | 0.00% |
| 241 Designer–Wood/ Furniture/Room design | Gestalter/in – Holz/Möbel/ Raumgestaltung | 0.00% | Specialists in interior design | Spezialisten in der Innenarchitektur | 1,238 | 0.00% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|--------------------------------------------------|--------------------------------|--------------------------------|----------------|----------------------------------------------------------|
| 242 Technician – Computer Science (Network Technology) | Techniker/in – Informatik (Netzwerktechnologie) | 42.00% | Specialists in IT network technology | Spezialisten in der IT-Netzwerktechnik | 8,863 | 42.00% |
| 243 Security Technician (IT) | Sicherheitstechniker/in (IT) | 80.00% | Specialists in IT network technology, IT coordination, IT administration and IT organization (other specific activities) | Spezialisten in der IT-Netzwerktechnik, IT-Koordination, IT-Administration und IT-Organisation (sonstige spezifische Tätigkeitsangabe) | 6,307 | 80.00% |
| 244 Business economist – Craftsmanship | Betriebswirt/in – Handwerk | 54.00% | Specialists in commercial and technical business management (without specialization) | Spezialisten in der kaufmännischen und technischen Betriebswirtschaft (ohne Spezialisierung) | 53,256 | 39.13% |
| 245 Business economist – Industry | Betriebswirt/in – Industrie, ie. | 29.00% | Specialists in commercial and technical business management (without specialization) | Spezialisten in der kaufmännischen und technischen Betriebswirtschaft (ohne Spezialisierung) | 53,256 | 39.13% |
| 246 Specialist for commercial business management (HwO) | Fachmann/-frau für kaufmännische Betriebsführung (HwO) | 27.00% | Specialists in commercial and technical business management (without specialization) | Spezialisten in der kaufmännischen und technischen Betriebswirtschaft (ohne Spezialisierung) | 53,256 | 39.13% |
| 247 Business administrator – Craftsmanship | Fachwirt/in – Handwerk | 36.00% | Specialists in commercial and technical business management (without specialization) | Spezialisten in der kaufmännischen und technischen Betriebswirtschaft (ohne Spezialisierung) | 53,256 | 39.13% |
| 248 Business economist | Fachwirt/in – Wirtschaft | 40.00% | Specialists in commercial and technical business management (without specialization) | Spezialisten in der kaufmännischen und technischen Betriebswirtschaft (ohne Spezialisierung) | 53,256 | 39.13% |
| 249 Technical-commercial skilled worker – craftsmanship | Technisch-kaufmännische Fachkraft – Handwerk | 33.00% | Specialists in commercial and technical business management (without specialization) | Spezialisten in der kaufmännischen und technischen Betriebswirtschaft (ohne Spezialisierung) | 53,256 | 39.13% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|-----------------------------------------------|--------------------------------|--------------------------------|----------------|-----------------------------------------------|
| 250 Technical business economist (further education) | Technische/r Betriebswirt/in (Weiterbildung) | 44.00% | Specialists in commercial and technical business management (without specialization) | Spezialisten in der kaufmännischen und technischen Betriebswirtschaft (ohne Spezialisierung) | 53,256 | 39.13% |
| 251 Technical specialist (m/ f) | Technische/r Fachwirt/in | 50.00% | Specialists in commercial and technical business management (without specialization) | Spezialisten in der kaufmännischen und technischen Betriebswirtschaft (ohne Spezialisierung) | 53,256 | 39.13% |
| 252 CAD specialist (without centre of gravity) | CAD-Fachkraft (ohne Schwerpunkt) | 75.00% | Specialists in design and equipment construction | Spezialisten in der Konstruktion und im Gerätebau | 95,402 | 77.75% |
| 253 CAD Specialist - Construction | CAD-Fachkraft - Bau | 70.00% | Specialists in design and equipment construction | Spezialisten in der Konstruktion und im Gerätebau | 95,402 | 77.75% |
| 254 CAD Specialist – Metal | CAD-Fachkraft - Metall | 86.00% | Specialists in design and equipment construction | Spezialisten in der Konstruktion und im Gerätebau | 95,402 | 77.75% |
| 255 Design engineer | Konstrukteur/in | 80.00% | Specialists in design and equipment construction | Spezialisten in der Konstruktion und im Gerätebau | 95,402 | 77.75% |
| 256 Technician – glass technology (glass design) | Techniker/in-Glastechnik (Glasgestaltung) | 36.00% | Specialists in handicraft glassblowing | Spezialisten der kunsthandwerklichen Glashäuser | 57 | 36.00% |
| 257 Parquet layer – Restoration work | Parkettleger/in– Restaurierungsarbeiten | 43.00% | Specialists in parquet laying | Spezialisten in der Parkettverlegung | 21 | 36.50% |
| 258 Restorer – parquet laying trade | Restaurator/in– Parkettlegerhandwerk | 30.00% | Specialists in parquet laying | Spezialisten in der Parkettverlegung | 21 | 36.50% |
| 259 Design consultant – interior decorator | Gestaltungsberater/in– Raumausstatterhandwerk | 18.00% | Specialists in interior design | Spezialisten in der Raumausstattung | 294 | 20.50% |
| 260 Business administrator – solar technology | Restaurator/in– Raumausstatterhandwerk | 23.00% | Specialists in interior design | Spezialisten in der Raumausstattung | 294 | 20.50% |
| 261 Business administrator – solar technology | Fachwirt/in-Sokrtechnik | 36.00% | Specialists in regenerative energy technology | Spezialisten in der regenerativen Energietechnik | 3,403 | 56.33% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|-----------------------------------------------|--------------------------------|--------------------------------|----------------|-------------------------------------------------------------|
| Service technician—wind turbine technology | Servicemonteur/in—Windenergieanlagentechnik | 73.00% | Specialists in regenerative energy technology | Spezialisten in der regenerativen Energiotechnik | 3,403 | 56.33% |
| Solar technician | Solartechniker/in | 60.00% | Specialists in regenerative energy technology | Spezialisten in der regenerativen Energiotechnik | 3,403 | 56.33% |
| Technician—Heating, ventilation and air-conditioning technology | Techniker/in - Heizungs-, Lüftungs-, Klimatechnik | 80.00% | Specialists in sanitary, heating and air-conditioning technology | Spezialisten in der Sanitär-, Heizungs- und Klimatechnik | 7,361 | 73.50% |
| Technician—Sanitary engineering | Techniker/in-Sanitäertechnik | 67.00% | Specialists in sanitary, heating and air-conditioning technology | Spezialisten in der Sanitär-, Heizungs- und Klimatechnik | 7,361 | 73.50% |
| Welding specialist | Schweißfachmann/-frau | 63.00% | Specialists in welding and joining technology | Spezialisten in der Schweiß- und Verbindungstechnik | 1,941 | 59.50% |
| Welding technician | Schweißtechniker/in | 56.00% | Specialists in welding and joining technology | Spezialisten in der Schweiß- und Verbindungstechnik | 1,941 | 59.50% |
| Blaster | Sprengmeister/in | 57.00% | Specialists in blasting technology | Spezialisten in der Sprengtechnik | 1,430 | 57.00% |
| Financial manager | Finanzwirt/in | 39.00% | Specialists in tax administration | Spezialisten in der Steuerverwaltung | 1,108 | 39.00% |
| Technician—computer science (technical computer science) | Techniker/in—Informatik (techn. Informatik) | 45.00% | Specialists in technical informatics | Spezialisten in der technischen Informatik | 5,079 | 45.00% |
| Specialist—Quality Assurance/Management | Fachkraft—Qualitätssicherung/-management | 57.00% | Specialists in technical quality assurance | Spezialisten in der technischen Qualitätssicherung | 53,055 | 57.00% |
| Technician—Environmental protection, (Water supply and disposal) | Techniker/in—Umweltschutz, (Wasserver- u. -entsorgung) | 55.00% | Specialists in environmental protection technology (other specific activities) | Spezialisten in der Umweltschutztechnik (sonstige spezifische Tätigkeitsangabe) | 192 | 55.00% |

(continued)
| Occupation title | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|------------------|--------------------------------|-------------------------------------------------|---------------------------------|-----------------------------|----------------|--------------------------------------------------|
| 273 Energy consultant | Energieberater/in | 25.00% | Specialists in environmental management and consulting | Spezialisten in der Umweltschutzverwaltung und -beratung | 5,580 | 41.00% |
| 274 Business administrator–Energy industry | Fachwirt/in–Energiewirtschaft | 57.00% | Specialists in environmental management and consulting | Spezialisten in der Umweltschutzverwaltung und -beratung | 5,580 | 41.00% |
| 275 Civil servant (m/f) - Surveying (technical service) | Beamter/in- Vermessungswesen (geh. techn. Dienst) | 88.00% | Specialists in surveying technology | Spezialisten in der Vermessungstechnik | 6,398 | 75.33% |
| 276 Civil servant (m/f) - Surveying (technical service) | Beamter/in- Vermessungswesen (geh. techn. Dienst) | 88.00% | Specialists in surveying technology | Spezialisten in der Vermessungstechnik | 6,398 | 75.33% |
| 277 Technician–Surveying technology | Techniker/in– Vermessungstechnik | 50.00% | Specialists in surveying technology | Spezialisten in der Vermessungstechnik | 6,398 | 75.33% |
| 278 Restorer–Carpentry | Restaurator/in–Zimmerhandwerk | 14.00% | Specialists in carpentry | Spezialisten in der Zimmerei | 245 | 7.00% |
| 279 Carpenter (m/f) - Restoration work | Zimmerer/Zimmerin– Restaurierungsarbeiten | 0.00% | Specialists in carpentry | Spezialisten in der Zimmerei | 245 | 7.00% |
| 280 Business administrator– Notary’s office | Fachwirt/in–Notariat | 29.00% | Specialists in law firm and notary’s office | Spezialisten in Rechtsanwaltskanzlei und Notariat | o.A | 29.00% |
| 281 Business administrator–financing and leasing | Fachwirt/in–Finanzierung und Leasing | 43.00% | Specialists in insurance and financial services (other specific activities) | Spezialisten in Versicherungs- und Finanzdienstleistungen (sonstige spezifische Tätigkeitsangabe) | 3,013 | 43.00% |
| 282 Roadkeeper | Straßenwärter/in | 0.00% | Road and tunnel attendants | Straßen- und Tunnelwärter/innen | 27,446 | 0.00% |
| 283 Construction draughtsman | Bauzeichner/in | 67.00% | Technical draughtsmen and women | Technische Zeichner/innen | 111,285 | 78.25% |

(continued)
| Occupation title (English name) | Occupation title (German name) | Automation probability per occupation title (in %) | Occupation group (English name) | Occupation group (German name) | Employee count | Averaged automation probability per occupation group (in %) |
|--------------------------------|--------------------------------|-----------------------------------------------|--------------------------------|--------------------------------|----------------|----------------------------------------------------------|
| 284 Technical system planner—Electrotechnical systems | Technische/r Systemplaner/in—Elektrotechnische Systeme | 83.00% | Technical draughtsmen and women | Technische Zeichner/innen | 111,285 | 78.25% |
| 285 Technical system planner—steel and metal construction technology | Technische/r Systemplaner/in—Stahl- und Metallbautechnik | 80.00% | Technical draughtsmen and women | Technische Zeichner/innen | 111,285 | 78.25% |
| 286 Technical system planner—supply and equipment techn | Technische/r Systemplaner/in—Versorgungs- u. Ausrüstungst | 83.00% | Technical draughtsmen and women | Technische Zeichner/innen | 111,285 | 78.25% |

Source(s): Bundesagentur für Arbeit (2019a), Bundesagentur für Arbeit (2019b), Institute of Employment Research (2019); own calculations